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NOTES.

Switzerland.—Andermatt, in Switzerland, is to be lighted by electric light.

Australia.—The Municipal Council of Hunters' Hill, New South Wales, have decided to light their borough with the electric light.

Copper Going Down.—The price for high-conductivity copper has been reduced ½d. per lb., making the present price of Nos. 0 to 20 10½d. per lb.

Killed by his own Servant.—M. Gillet, a telegraphic operator at the Vaise Station, Lyons, was killed by lightning while transmitting a message.

Bournemouth.—Mr. Jennings has supplied and fixed an electro-mechanical water level indicating apparatus between the sea water pumping station and the reservoir towers at Bournemouth, for the Improvement Commissioners.

Montpelier.—The opening of a central station for Montpelier is announced for July 14th. The installation will consist of 50 arc lamps of 1,200 candle-power on the Thomson-Houston system for the public streets, and 2,000 incandescent lamps for private houses.

Personal.—We learn that Mr. James Campbell, having left Messrs. J. H. Carruthers and Co. some time ago, has joined Messrs. Mechan and Sons, of Glasgow, who have large connection with shipbuilding and engineering works, for whom he is opening up an electrical department. Power is to be a special feature of the department.

South Kensington.—The answers to the questions in magnetism and electricity set at the recent examination at South Kensington will be found in the June and July numbers of our contemporary, *Science and Arts*. The answers have been contributed by Mr. Walter Hibbert, lecturer on magnetism and electricity at the Polytechnic Institute.

Halifax Town Council.—At the last meeting of the Town Council, Messrs. England and Foster, solicitors, forwarded an application from the Schmidt-Douglas Electric Lighting Company, making proposals with a view to lighting the principal portion of the town with electricity before the coming winter. The Mayor said he would call a meeting of the Council in committee at an early opportunity to consider the matter.

Solid Petroleum.—Dr. Kaufman, for the Russian Government, has made some experiments with the view of rendering petroleum solid, and therefore more useful as fuel. He has found that an addition of 1 to 3 per cent. of soap to heated petroleum renders it, when cool, as solid as tallow, and looking something like blocks of cement. It is then hard to light, but burns with great heat, and leaves a residuum of about 2 per cent. of black deposit.

Australian Cable.—The Eastern Extension Telegraph Company notifies the interruption of its two cables between Java and Australia. A steamer has been chartered to carry telegrams during the interruption, which will leave Java to-day, and is expected to arrive on the 11th inst. at Port Darwin, whence the telegrams will be transmitted by the South Australian land lines to the various colonies. A repairing steamer leaves Singapore immediately to effect repairs, and it is expected that communication will be restored in about ten days' time.

Book Received.—"Electricity *versus* Gas" is a little pamphlet of 70 or 80 pages, published by Messrs. Swan, Sonnenschein, and Co., and written by Mr. Jno. Stent. It professes to be a popular account of the lighting by means of electricity and by means of gas, the conclusion of the author being that the former must sooner or later entirely supersede the latter. We do not know that the pamphlet contains anything very scientific. On page 57 Sir Henry Thomson should be Sir Wm. Thomson, and London should be Glasgow, according to our recollection of the facts of the case.

Private House Lighting.—We are pleased to see that it is becoming more general to put the electric light into new houses which are being built, the instances of which are daily increasing. We understand that Messrs. Drake and Gorham have put the electric light throughout the whole of the new mansion which has been built by Mr. Kingswell, at Bentley Priory, no other illuminant being provided for. Messrs. Drake and Gorham, who are contractors for the work, have fixed a Marshall steam-engine and boiler, driving an Elwell-Parker dynamo, which supplies current for 57 of their latest type cells.

Edison's Patents.—A great flutter has been caused in electrical circles in America, which we over here do not feel the effect of, in the breakdown in the United States Court of Edison's master lamp patent. This has practically thrown the whole industry—carbon or not carbon, filament or not filament—open to the trade, and has naturally caused great jubilation on the part of the Edison Company's legal opponent—the United States Electric Lighting Company. The earlier patent was taken out in Austria; this has been allowed to lapse, and the Court decides that this failure in the foreign country invalidates the American patent.

Encouragement.—We hear that Mr. Edward Weston—the originator of the Weston system of electric lighting—has just been elected the President of the American Institute of Electrical Engineers. Mr. Weston was born in England in 1850, and when quite young amused himself with Smee's "Elements of Electro-Metallurgy," and such things, describing how to make electrical experiments Soon after sixteen years of age he began the study of medicine at the wish of his parents, did not like medicine, went to the United States in 1870, began work there for the American Nickel-Plating Company, and since has used hands, eyes, and head, and is now near the top.

Electric Door Opener.—A great deal seems to be done with electric door openers in America. As you step on the mat contact is made, the bolt withdrawn, and the door calmly opens before you. We do not remember to have seen these in the various catalogues of electrical sundries we have had submitted to us. There might be an opening for some business in this as well as in many other directions for electric novelties for shop purposes, especially in connection with a good dry cell. We feel sure the public would take up electric novelties of this kind with greater avidity if they were submitted complete in detail, and if little trouble for attention could be guaranteed.

Edison's Troubles.—Thomas A. Edison, the inventor, is now dividing his time between the joys of paternity and experiments upon a new electric flying machine which he has been commissioned by the Spanish Government to make for war purposes. The system will be one of revolving fans, to which power is supplied by means of a wire connecting with an electric dynamo on the earth. The fans are not only to propel, but lift the air ship. Then with a properly

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equipped car an officer can ascend and take photographs and sketches of the enemy's position, which will give a great strategic advantage to the Spanish commander. Mr. Edison is confident that his experiments will result successfully.—*New York Tribune.*

Weber and Schefbauer's Insulation.—These gentlemen take two or more wires placed at a suitable distance, and cover them with paper strips previously passed through a bath of ammonia oxide of copper. This paper band now bears upon its surface a coating of cellulose. The whole is then forced through suitable rollers, the cellulose of one spiral uniting with that of the next, forming a complete whole. The coated wires are again passed through the copper bath, and then through another pair of hot rolls, the lead coming out dry and smooth. While still warm it passes into a bath of boiling linseed oil, and is again passed through the rolls, which throw out the excess of oil, and the strip is supposed to be perfectly flexible, elastic, and insulated against damp at any rate.

Electrical Patents.—The number of applications for patents in America for electrical appliances is phenomenal. During the week ending May 29, 73 patents were issued from the Patent Office A general sub-division into various recognised departments is interesting, as showing those in which inventors are most busily engaged:—There are 14 patents relating to instruments and devices of measurement and testing, 2 to telegraphy, 2 to the telephone, 3 directly to the motor, 4 directly to the galvanic battery, 4 directly to the secondary battery, 1 to a thermo-electric generator, 26 to dynamos and electric light apparatus and the transmission and distribution of electricity for purposes of light and power, 17 to miscellaneous applications. Among those relating to electric light apparatus, are quite a number covering a whole alternating current system.—*Scientific American.*

A New Constant Cell.—In a communication to the Académie des Science, MM. Fabrigi and Farkas, describe a new constant cell. This cell consists of a small platinum vessel, coated on the inside with a compound having the formula given as $Na_2H_{12}Pt_2O_{11}$, and which is formed by heating the platinum in contact with caustic soda. The vessel is filled with fused caustic soda, maintained in a fluid condition by means of a small gas jet. The positive electrode consists of platinum; the negative one of gas carbon. On closing the circuit, the E.M.F. soon assumes a steady value, as the carbonate of soda produced is continuously eliminated and deposited in a crystalline form on the free surfaces of the electrodes. The E.M.F. depends on the temperature, but the temperature coefficient is so small, that with an ordinary gas flame the E.M.F. may be maintained sensibly constant for several hours. Large and sudden alterations in the external resistance merely cause a momentary change in the E.M.F., which almost immediately returns to its original value.

Heights of Clouds.—The cloud illumination caused by the electric lights of Detroit and Ypsilanti is occasionally so well defined in outline, as seen from this observatory, that it occurred to the director to inaugurate a series of altitude measurements for the purpose of determining the heights of all forms of clouds visible at Ann Arbour after twilight. The central portion of Detroit is about thirty-five miles from the observatory, while Ypsilanti is only 5·8 miles distant. The azimuths of the two cities differ about 30 degrees, so that the conditions for determining the heights of the upper and lower clouds can always be made favourable when the atmosphere is sufficiently transparent. When the clouds are very high, the Detroit illumination is so well defined that the probable error of a single measurement of an altitude is only a few minutes of arc. When the clouds are low, the nearer illumination is well defined, and the farther one either invisible or coincident with the apparent horizon. The greatest and least heights recorded up to the present time are respectively 17,580 and 770ft.—*Amer. Meteo. Jour.*

Electric Fire-Engines.—We are evidently only just waking up to the numerous and extended uses the electric current can be put to when a full and thorough distribution of power is possible by means of mains. Not only has it been proposed to apply permanent motors for the pumping water for house supply, but an inventor is to the fore with an electric fire-engine. Connection could be made on the incandescent circuit to run a motor for throwing the water. Double electric cables and a motor force-pump will be all the machinery required, if proper means are secured for electric connections or fire-plugs. The great advantages claimed for the electric fire-engine are that it can be instantaneously started up at full speed; that it is much lighter than a steam fire-engine of equal power; that it costs one-third less; that it is safer and easier of control; that it is noiseless in its operation; and that it is economical. Where there is no general electric distribution, it might prove practicable to run the motor both for carriage and for pumping by means of storage batteries, sets of which could be kept ready charged at the fire-engine station.

Great Chances for Three Inventors.—Prof. R. H. Thurston, in the May *Forum*, states that the world is awaiting the appearance of three inventors, greater than any who have gone before, and to whom it will accord honours and emoluments far exceeding all ever yet received by any of their predecessors. The first is he who will show us how, by the combustion of fuel, directly to produce the electric current: the second is the man who will teach us to reproduce the beautiful light of the glow-worm and fire-fly, a light without heat, the production of which means the utilisation of energy without that still more serious waste than the thermo-dynamic now met with in the attempt to produce light; while the third is the inventor who is to give us the first practically successful air ship. The first two of these problems are set for the electrical engineer, and we may be pardoned excess of faith should it prove to be such, when, contemplating the enormous gain to humanity which must come of such inventions, we look confidently for the genius who is to multiply the wealth of the world to an extent beside which even the boon conferred by the creators of the steam-engine and the telegraph will not appear overshadowing. When this inventor comes forward, and most probably not till then, it is very likely that we shall see steam superseded by a rival.

Luxurious Cars.—The Chicago, Santa Fe and California Railway, says the *National Car Builder*, have running between Chicago and Kansas City a service of vestibule trains, the cars of which are large and commodious, built in the most substantial way that skill and experience could devise, decorated without regard of expense with rare artistic taste, and furnished with the most luxurious equipment that could be conceived as likely to conduce to the comfort and safety of passengers. Each train consists of nine cars, one baggage, one mail, one second-class, two first-class, combined parlour and smoker, one dining and two sleeping cars. The whole train is vestibuled from the baggage car

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to the rear. The entire train is heated by steam from the locomotive, and lighted by electricity supplied by a dynamo run by a Brotherhood engine placed in the baggage car and supplied with steam from the locomotive. Storage batteries are also carried on the cars for providing a supply of electricity when from any cause the rest of the train is parted from the baggage car. The train is fitted up with the new Westinghouse quick-acting brake and the pneumatic train signal, but it has an electric system of signalling besides. The trucks have 42in. Allen paper wheels. The Miller coupling is worked by a ratchet arrangement placed on the steps of each car, and the hand-brake is geared to supply the necessary power should hand-braking be necessary.

Efficiency of Dynamos.—A simple and practical workshop method of estimating the commercial efficiency of dynamos is pointed out by *L'Electricien*, as used by M. Hippolyte Fontaine, and given in the third edition of his work on electric lighting. Until the invention of a thoroughly practical and reliable transmission dynamometer, this method may be usefully employed to verify the efficiency of identical machines; it requires merely the use of an ammeter and a voltmeter properly graduated, but not necessarily absolutely accurate. The two dynamos are placed one behind the other, and connected together by a belt; the first receives the current of a third dynamo driven by any engine, the second produces a current closed through an easily regulated resistance. The variable resistance is altered until the two currents are equal. Calling I the common current of the two currents, E the difference of potential at the terminals of the machine acting as motor, and E′ that of the machine acting as generator, the power given is evidently equal to E I, and the power produced is equal to E′I. The efficiency of the whole is, therefore, equal to $\frac{E'}{E}$; and the probable average efficiency of each, if they are similar, is $\sqrt{\frac{E'}{E}}$ on condition that the two machines have the same power as motor and as generator. This method is simple, rapid, accurate, and is easily and directly applicable in workshops for the construction of dynamos.

Subways.—Mr. Albert R. Ledoux, at the close of an article in the *Evening Post* on English and Continental practice in this matter, summarises European practice as follows: The whole situation to-day in Europe, including Great Britain, may be summed up as follows: Telephone service, overhead, small copper wires on neat standards upon housetops, owners compensated for use of roof. Poles only allowed where roof service is impossible. Telegraph service, largely underground in England, and on housetops elsewhere. Electric (arc) light service practically all overhead. So complex and intricate a tangle as the subway problem in New York is not even dreamed of in Europe, much less solved. With our growing electric light service, our district-messenger calls, and, above all, our great telephone system; with our network of gas and water and steam pipes in the street, we have a problem that we must work out practically alone—unaided by European experiences. Radiating from our metropolis, like the threads of a gigantic spider's web, including and connecting neighbouring cities and growing towns, and even distant cities, already there stretches a network of wires along which throb the impulses of our commercial life. We think the problem of their location difficult to-day; what will it be when every man has a telephone in his house; when gas light within, as well as without, gives way to the electric light; when our streets must yield yet more room for fuel-gas pipes, larger water-mains, &c., &c.—what shall then be done?"

What Shall We Read?—Under this title, Mr. T. D. Lockwood contributes an article to our contemporary, the *Electrical World*. In it he considers the technical newspaper, and upon this subject we quote the following remarks:—"It is right to say that an electrical library, no matter how complete, cannot take the place of the electrical newspaper. Every man engaged in applying electricity should make a point of taking that one of the weekly electrical periodicals which, after due inquiry among his associates, he decides to be the best adapted to his wants. If he can afford more than one, he ought to take one English and one American periodical; or if his treasury be sufficiently plethoric, he will find it advantageous to subscribe for all of the American weekly and monthly electrical periodicals, and also for the British *Electrical Review*, *Electrician*, or *Electrical Engineer*. Unless he be a linguist, it would not be advisable to take a technical paper printed in a foreign language, because the main portion of the electrical news of the day is to be found in all of the journals printed in the English language; while any subject of general interest will likewise be certain to be found in at least one of them. I have considered it expedient to speak first of electrical journals, because this is a generation that necessarily, to hold its own, must act in the living present; and though a man working now in electricity were thoroughly versed in the archæology and antiquities of the science, and though to this knowledge he add an extensive acquaintance with college text-books, this all amounts to very little if he fail to keep himself fully informed of the progress of the day; for history in electricity is now a matter of days, and is more rapidly made than ever before. The only way, therefore, to hold one's own is to peruse and study the journals. But in addition to these, if we desire to have full information—in short, if we desire to excel—we require something more. It is true that the number of books is legion, but I imagine that half-a-dozen of well-chosen books will be all that a young man needs at the outset, and they will form a good nucleus round which a library may be built by slow but solid accretions.

Telephone Catalogue.—We have received the very complete catalogue of telephonic requirements issued by the Consolidated Telephone Construction and Maintenance Company, Limited, 109, Farringdon-road, E.C., the sole licensees for the Bell, Edison, Blake, and Gower-Bell systems for the United Kingdom. Apparatus is therein described and fully illustrated, suitable either for a private installation of a pair of telephones or a fully-developed exchange, with all accessories, for which the company undertake contracts and, if required, negotiate for concessions. The "consolidated" magneto telephone, and "consolidated" battery telephone, are shown, together with the Gower-Bell or ordinary Post Office pattern. Diving telephonic apparatus, fitted to diver's helmet, with small box and battery for shore end, is largely used by the Admiralty. The Gower-Bell portable telephone for field or military purposes, contained in a small square box, and a similar form for miners, are convenient forms of the combined apparatus. The operator's receiver has been designed to leave the hands perfectly free, and is mounted on a strop or band, which goes over the head and allows the receiver (or two if preferred) to come close over the ear. This form is largely used in Lisbon by subscribers who wish to hear the

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opera without leaving their residences, and is greatly appreciated. The Bell-Blake magneto and battery telephones are forms supplied to subscribers by the United Telephone Company of London and their subsidiary companies. Magneto call-bells, operators' telephones, exchange switch-boards, and annunciators, each have their department illustrated. The automatic call box, set in motion by the weight of the necessary coins, is very popular, and its use is extending. The call-box is placed under the care of some local and influential tradesman. The person wishing to communicate places the required coppers in the slit, and the electrical contact is then made automatically with the Telephone Exchange, who connect as desired, and the current is cut off automatically after a certain period of time. A small magnetic generator is shown for use with call-bells, which is also used for testing electric light circuits. The Consolidated Company also supply "Simplex" arc lamps, single or double for parallel working. For greater convenience in telegraphing, a special telegraphic code is given at the end of the catalogue.

Electric Lamp-Posts.—We note in a report from Berlin, with reference to electric lighting in that town, that architects have been invited to send in designs for lamp-posts. This is, we fully believe, a step very much in the right direction. On a new town installation being put down the technical journals, of course, will treat most fully of its electrical character, the ingeniousness and stability of its engineering part; but intending central station installers had better be quite aware that for the public quite as much will depend on the design of the lamp-posts as upon the proper arrangement of the distribution. The comparative strength of the light and the proper reflecting arrangements are also points on which every town councillor and local architect will certainly have his own opinion, though as to whether a friction clutch or an extra gas-engine be employed he is not able to be so sure. If in the same manner, at the outset the central station engineers clearly acknowledge and lay themselves out for the proper pleasing of the eye of the *cognoscenti* in the matter of lamp-posts, they will go a long way to pave the way for great future extensions of the system. From some of the specimens we have seen, this point seems to have escaped altogether the business acumen of the original promoters of the electric lighting industry. Large iron tubes, with coarse tee-pieces of iron barrel, have been made e'er now to do duty as electric lamp-posts in a permanent installation. Nor would it be much better to take the designs of manufacturers of gas-lamps and get them to modify these designs for gas. As a rule there is very little really artistic about them, and the modification would not improve the matter. We in England at this present moment are not without talent which will enable us to produce something really commendatory to all, at a price not far in advance of modified gas lamps; and the step the Berlin authorities have taken is one in the right direction. There are, we are quite sure, many quite able to design such fittings among the architects, men who would be able to put real beauty and proportion into these standards, which are probably henceforth to be landmarks in every street. Let us imagine for one moment, how such a desideratum would have been treated in the palmy days of Venice, Verona, and Florence, and, reflecting on the remark recently made by Sir Frederick Leighton, that English art is, at least, as great as Italian, let us also hope that English municipal and engineering enterprise is at least as good as German, and let us try and see our way to the fulfilment of this requirement.

Magnetic Perpetual Motion.—As the question of perpetual motion by means of a magnetic insulator is continually cropping up in the ingenious minds of students, we give the following answer to a letter addressed to the editor of the *American Machinist* upon the question, as to whether magnetic force acts through every known substance. The letter disagreed with the statement that there was no magnetic insulating substance known, and stated that it is a fact that magnetic force will not act across a screen of iron or other magnetic substance, as nickel, cobalt, and a few other substances, and referred for a statement of this, and description of experiments to prove it, to Prof. Silvanus Thompson's "Elementary Lessons on Electricity and Magnetism," p. 77. In answer the editor says: "The statement in the book referred to says that 'a magnet enclosed in a hollow sphere of iron is unaffected by outside magnetic influence.' This, however, is not due to the iron being an insulating substance at all, because it is not an insulating substance. Two magnets, between which a sheet of iron is interposed, still attract each other, and will do so through any known substance, through a flame, through any known gas, or through a vacuum. The fact that a sphere of iron acts in this way seems to be due to a balancing or absorption of the magnetic force, due to the form in which the metal is disposed, rather than to the character of the metal itself—a fact which seems plainly demonstrated when we consider that if the half of the sphere furthest from the outer magnetic force be removed, the force will act through the other half. It will seem from this, that in the sense in which the original question was meant our answer was correct. Numerous individuals have thought that they could produce perpetual motion by mounting two permanent magnets at the ends of levers in such a way as to be attracted toward each other, and by their movement cause a thin sheet of insulating material to be interposed, thus cutting off the attraction, and causing the magnets to recede from each other by the action of gravity, or of a spring; this action in its turn removing the insulator, and allowing the magnets to again attract each other, thus producing a motion which would go on indefinitely without the expenditure of external forces. Among all the many schemes to produce perpetual motion, this perhaps seems upon the face of it to be the most feasible. But, as if Nature has deliberately calculated to defeat every plan to produce such a motion, she fails to furnish the required insulating substance: at least it has never been and we believe never will be discovered." We might also point out that when two permanent magnets have attracted each other, their molecules have lost a certain amount of kinetic energy, and are no longer such strong magnets. To give them back this energy it is necessary to forcibly separate them; this action returns the magnetism by the action of elbow grease or other mechanical power, and any substance, insulating magnetically, even if found, in order to make such a machine work, would also have to contain the power of returning the lost magnetic energy, which is not what we should call probable.

Clark Standard Cells.—Notwithstanding, says Mr. D. Woodman in the *Electrical World*, the exceedingly satisfactory results obtained by Lord Rayleigh, and the high estimate placed by him and others on the accuracy and value of the Clark standard element, the notion prevails to a considerable extent that his results are so difficult of duplication as to make a reliable Clark cell more a scientific curiosity than a *practical* standard E.M.F. Taking up the subject about a year ago at the request of Mr.

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J. W. Howell, of the Edison Lamp Company, a number of cells were made up which have been compared with each other on an average of once a week since the fourth day after their completion, without at any time recording a difference in their values of as much as $\frac{1}{10}$th of 1 per cent. Six parts in 8,000 has been the extreme difference, and usually not over three or four parts, while agreement is frequently so close that the slight variations are not more than possible errors of reading, or probable variations in temperature. 1deg. C. causes a variation of eight parts in 10,000, or slightly less than $\frac{1}{10}$th of 1 per cent., according to determinations made by Rayleigh. Although the differences among many of his cells were stated at less than two parts in 10,000, he sums up his experience in the statement that he "believes that cells properly made will not vary, at ordinary temperatures, more than $\frac{1}{1000}$ part of their value—*i.e.*, not more than one tenth of 1 per cent." This has been considered a satisfactory standard to attain in the work of the past year. As to whether differences under one-tenth of 1 per cent. are enough to unfit the cell for any particular work, the electrician can decide for himself, and undertake the preparation of a standard of greater accuracy for special cases. But for work of a very considerable degree of accuracy such small variations will not be of importance. A battery of six standard elements prepared for Mr. Edison's laboratory at Orange, one month after being set up, differed two parts in 8,000, and up to date no greater difference has been reported. Its convenience of form and permanence, when properly prepared, are the reasons why its employment would have been very general but for the shaken confidence resulting from disagreement of cells prepared by different persons, and want of permanence in many of those sold commercially. Non-transportability except by hand has also been to some extent a drawback, and a modification whereby this difficulty has been overcome will be an additional point in favour of convenience. As to difficulties of preparation, not the least is the mechanical one of a satisfactory seal against evaporation, which is the only enemy to otherwise well-prepared cells. The remaining difficulties are purely chemical, and it is neither unfair to the amateur in chemical work, nor awarding too much to the chemist, to say that these difficulties are not likely to be appreciated or obviated by those without some training in exact chemical work. Not only is it difficult to purchase strictly pure chemicals, but also to prepare them, and where one article purchased may be all that could be desired, another will introduce a disturbing impurity; so that without analysis no purchased article can be safely used, unless one is willing to undertake the tedious and expensive method of trial and failure until something sufficiently good is obtained.

The British Association.—A meeting of the Executive Committee was held at Bath last Friday under the presidency of the Mayor. Amongst those present were the Rev. Canon Brooke, Rev. H. H. Winwood, Dr. Tuckett, Mr. Murch, Mr. R. Porter, Mr. Norman, Mr. H. Holland Burne, Mr. R. S. Blane, Mr. J. S. Bartrum, Mr. F. Mason, Mr. John Stone, Mr. W. G. Wheatcroft, Mr. J. S. Turner, Mr. Milsom, Mr. Daubeny, Mr. Plowman, Mr. R. D. Commans, Mr. R. King, Mr. W. C. Jolly, Mr. H. W. Freeman, Mr. Horner, Mr. Braham, Mr. Jas. Williams, and Mr. J. L. Stothert, Mr. W. Pumphrey and Mr. B. H. Watts (hon. local secretaries), and Mr. Norfolk (assistant secretary). It was reported that the Reception Committee required £1,750. This covered the expense of erecting and fitting up the reception room in Alfred-street, the hire of the Assembly Rooms, and also the expenses of fitting up the drill hall. It did not include the cost of messengers. A canvass of lodging-house keepers had been made with the view of ascertaining what accommodation they had to offer. A circular had also been drawn up, and would be sent out shortly, asking private citizens whether they would be willing to entertain any of the visitors. Mr. Stothert said he had been in London during the past day or two conferring with Mr. Aitchinson, the general secretary. A meeting had been convened, when Mr. Aitchinson would attend in person and give them the benefit of his experience in these matters. Mr. Wallace Arnold roughly estimated that the lodging-house keepers would be able to accommodate 2,000 visitors. Mr. Stothert said the subscriptions were coming in to some extent, and the newspapers would this week contain a second list of subscribers. They were not up to the sum they wanted by a good deal, and from what he saw he thought that the expenses, instead of diminishing, were likely to go the other way, therefore it was very important that they should have as much aid as they could. Mr. Murch, chairman of the Finance Committee, found that the estimated expenses already made up amounted to £2,890, without contingencies. Upon the application of Mr. Turner, the sum of £75 was granted for the preliminary expenses in connection with the various excursions. The Mayor said he had written to the Marquis of Bath asking him for permission to make arrangements for an excursion to Longleat, and he had no doubt but that permission would be accorded.—At Newcastle, on Tuesday, a meeting of the Local Committee in connection with the visit of the British Association to Newcastle in 1889, was held in the Mayor's Chamber, Town Hall, Dr. Phillipson presiding. Amongst those present were Prof. J H. Merivale (hon. secretary), Prof. Lebour, Prof. Bedson, Dr. Spence Watson, Dr. Oliver, Mr. Martin, Mr. W. G. Laws, Mr. Dinning, Mr. Thos. Hunter. The three editors of the Local Guide are as follows: Historical section, Dr. T. Hodgkin; natural history, Prof. Lebour; industries, Mr. Wigham Richardson. The object of the guide is to put into the hands of visitors a brief sketch of the industries, natural history, and general history of the Northern counties. The minutes of the Local Guide Sub-Committee were approved. The next business was to consider the calling of a public meeting. The Mayor was willing to place the Council Chamber at the disposal of the meeting. Prof. Merivale thought they should have the Town Hall if they could fill it. Perhaps they should have another stage before calling a large meeting like that. It would be necessary to have two meetings before the Bath meeting on September 5th—one, a public meeting to elect a General Committee, and a meeting of the General Committee to transact certain business. They would have to inform the Bath meeting who was appointed local secretary and treasurer. The secretary would have to go to Bath to pick up what information he could. The 10th of July, in the Council Chamber, as the date for the public meeting, at four in the afternoon, was agreed to. The meeting agreed upon a list of local corporate, literary, scientific, and professional bodies who should be asked to nominate members of the Local General Committee. It was agreed to recommend that the minimum subscription for members of the General Committee should be two guineas. It was agreed that there should be a paid secretary at a salary of £100 a year.

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ARTISTIC FITTINGS.

III.—Binswanger and Co.

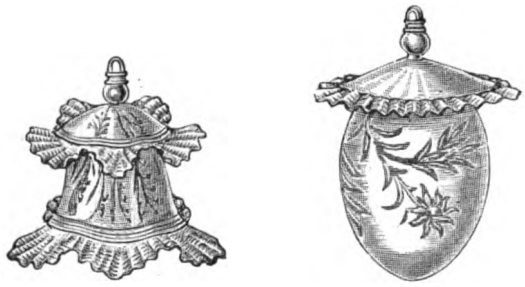
In contradistinction to the d scriptions we have previously given, and shall hereafter give, of artistic fittings, definitely designed and manufactured primarily, one may say, for their artistic effect, and the cost of which is reduced only to within the limits of a fair profit on the expense and time employed in manufacture, we give this week specimens of fittings avowedly designed from the other point of view —namely, to be supplied as cheaply as possible in quantities, and invested with as much artistic merit as possible, allowing the fair margin of profit.

Flower Pattern Etched Shades.

Taking the point of view of cheapness first, and as much artistic look as can be obtained at the same time, it has long been evident to electrical engineers that the simple hanging cord pendant makes the simplest, cheapest, and prettiest fitting for the electric light. There are certainly many positions in considering the electric light as to be applied in lighting, in which cord pendants would not be sufficient ornamentation—the space requires more filling, and the taste, together with the pocket of the owners, inclines towards something more spacious and more ornate. But there is always this to be said about cord pendants, they never look like gas-fittings. Many electric light fittings are not yet free from

Cut and Etched Shades.

the thraldom of the designs of gas-pendants, and, notwithstanding the difference of the globes and shades, can still, without much difficulty, be taken for ordinary gas-pendants. This cannot be the case at all with cord pendants hanging by a light suspension from the ceiling; and this is often a great point with the happy owners of the only safe illuminant. They want it to be clearly known and noticed that they have invested therein. On both counts, therefore, it is evident that as electric light extends, whatever may be the case with more elaborate fittings, cord pendants will always have a great demand.



Etched Shades with Glass Mantle.

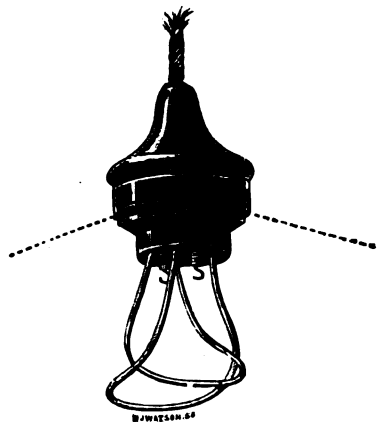
Messrs. Binswanger and Co., of Great St. Thomas Apostle, trading under the name of the General Electric Co., have for some considerable time devoted their attention to the large supply in quantities of various electrical requirements in the way of fittings, and have made a special point of the question of cord pendants. We illustrate this week some of the special designs which this firm have introduced; many of these will prove very useful to installers of electric lighting on the lines we have pointed out.

One of the chief difficulties which have laid in the way of a more extended and cheapened use of small and pretty fittings, has been the want of uniformity, or of a standard, in the sizes of the fittings employed. For instance, in the matter of glass shades, it has been up till now the habit with these articles to make them with all and sundry sizes of neck openings. Some shapes will have 2in. openings, others $2\frac{1}{4}$, $2\frac{1}{2}$, or 3in., at will and without method. It is most irritating when customers have sent to ask for a certain kind of shade, with, say, $2\frac{1}{4}$in. opening, to find that the shade is in stock, but cannot be sent because the opening is $\frac{1}{2}$ or $\frac{1}{4}$ of an inch too large or too small.

Ribbed Moulded Shade.

Iced Opal Reflector.

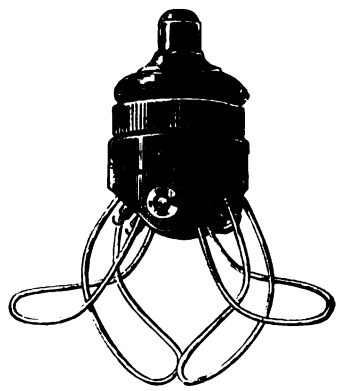
This is certainly a point on which it might be well for the general trade to combine, and arrange for certain most convenient standard sizes. Pending any such united action, Messrs. Binswanger, recognising the desirability of having one standard opening, have been making all the openings



Standard Holder for $1\frac{1}{8}$in. Opening.

of glass shades for pendants of one size—namely, $1\frac{1}{8}$in., which they have found a size most convenient all round. This will take any ordinary holder with a cap, but they make a standard holder which fits this size glass without flange or cap, and is thus most easy to fit or alter.

A large number of the glass shades for cord pendants are made with various flower pattern designs etched on the



Standard Holder for Two Lamps.

surface of the glass, of which we give several illustrations. These have a subdued and ornamental effect, and are made in various shades of colour—opal, blue, yellow, amber, ruby, and white. Another form which has a very pleasing effect is that of the mixed cut and etched patterns, of which we also give illustrations. The mixture of subdued light with the sparkle of the cut glass is sometimes very effective.

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Another type of pendant is shown with a double glass shade, the bottom being either a shade or a globe, and having an ornamental glass mantle over. A cheaper form is that of a moulded and ribbed shade, produced in various forms and many colours. The ordinary opal reflector is much improved in appearance when made in iced glass as shown.

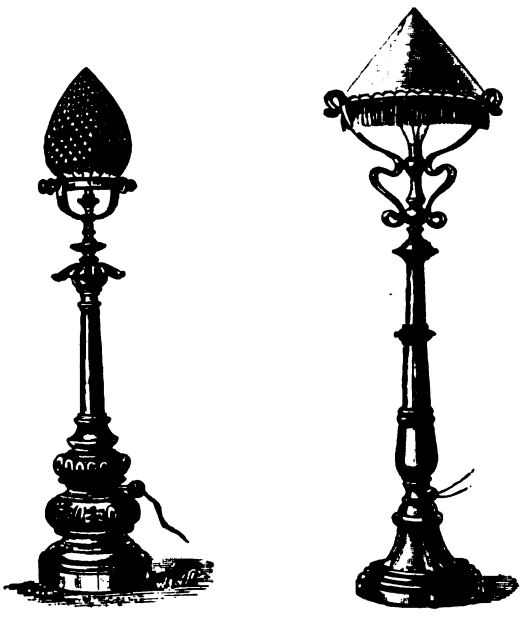
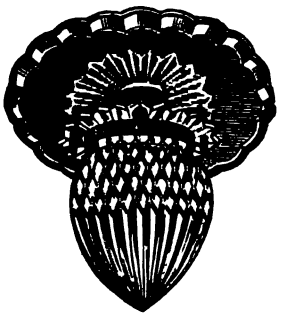


Table Standards.

Of table standards this firm make several patterns of neat design and very moderate price; we illustrate two of these—one with a glass and silk shade, and one with cut-glass pine shade. Other fittings are also made with cut glass combined with mirrors, which have a very brilliant effect; when the light is in, the combined reflection and refraction from mirror and cut glass enhances the general effect very considerably. These kind of fittings have been much supplied to coffee-rooms and other apartments for hotels.



Cut-glass Globe and Mirror Reflector.

Throughout, as we have indicated, Messrs. Binswanger have paid special attention to the supply of glass shade electric light pendants in variety, and by the application of business methods for production of large quantities are enabled to supply them at very moderate prices, and we have no doubt will meet with the appreciation from the trade which they aim at in these departments. They have besides given some attention to floral brass fittings, and have lately supplied some very handsome beaten brass fittings of Oriental design in the form of large decorative pots of flowers, fitted with electric light, for two Indian rajahs. They have also several novel electric specialities not coming under the head of artistic fittings, which we hope to illustrate shortly.

NOTES ON BELTS AND BELT-DRIVING.*

BY JOHN N. COOPER.

The importance of this detail in the designing and erecting of any electrical installation or in laying down factory plant, &c., has induced me to bring before your notice a few data which I have recently been collecting, having reference to this subject, in the hope that information I can give will be of use to some of the members present at this meeting.

The requirements of a good belt are: 1. That it shall have great tensile strength. 2. That it shall get a good grip on the pulley. 3. That it shall be made of a material which will have a long life under the specified conditions.

The materials most generally used in the manufacture of machine belts are: Leather from the hides of various animals; cotton hemp, &c., woven into the form of a belt; gutta-percha and indiarubber laid on to a foundation of cotton or some such substance; and in quite recent years the hair of animals, such as the camel and lama, has been woven into belts.

Ordinary leather belts are made from strips cut from the central part of the hide, called the butt. This is the most solid part of the hide when tanned, and the texture is the most uniform. The strips of leather are then joined together, forming a piece of belting. In the process of manufacture the leather undergoes a process of stretching, so that when the belting is put on to any work its stretching is reduced as much as possible.

The size of the butt of an ox-hide is about 4ft. 6in. long by 4ft. wide, and so the strips of which a good belt is made should not exceed 4½ft. in length. If the strips are much longer than this you can, tell at once that some part of the offal has been used, and the belt has been made up of leather of uneven quality—parts of the belt stretching more than others. When cheaper belts are made, a longer strip is cut out of the hide.

Different makers employ different methods of joining the strips together for the purpose of making a continuous length of belting. They all aim, however, at getting a joint which shall be as strong as possible, as pliable and as smooth as the body of the belt, and which, for these reasons, will run over the pulleys without any jerking or unevenness.

A kind of belting which has been used to a considerable extent in electric lighting jobs in this country and in America is made by Mr. J. B. Hoyt, of New York, and is known as "Hoyt's short-lap leather belting." In the manufacture of this belting the butts of oak-tanned hides are used, and the joints are made with very short laps. The scarf joints are then made firm in one of the usual ways—viz., either (1) cemented and then sewn; (2) cemented and riveted with copper rivets; or a combination of the two methods—cemented, sewn, and riveted. In this way a belt is made up having the same side of the leather next the pulley for the whole length.

Another kind of belting well known to electrical engineers is the "Victoria belting." The leather used in the manufacture of this belting is also cut from the butts. The spongy side is then pared away by special machinery, and the whole is reduced to a uniform thickness. This process, the makers claim, does not weaken the belt, and it undoubtedly makes it more pliable. A double Victoria belt is generally used. This is made by cementing two thicknesses of pared leather together, and then riveting through with copper rivets; a double Victoria belt is very little thicker than ordinary single leather belt. The Victoria belt is run with the hair side of the leather next the pulleys.

Messrs. Tullis and Sons, of Glasgow, are working a belt known as "orange tan leather." This belting is made from Highland ox-hides, and is tanned with a preparation of orange, instead of oak bark, which is generally used in tanning. In the process the leather, instead of swelling, as is the case of oak-bark tanning, shrinks and becomes thinner. When tanned, it weighs nearly 50 per cent. lighter than if oak-bark tanned. The breaking strain of belts prepared in this manner is very much greater than that of ordinary tanned leather.

An ingenious method of joining the strips of leather has been invented by Mr. Jardine, of Nottingham. This join has been designed so as to give double the usual surface of contact between the two faces of the leather which has to be cemented together. There is (so Mr. Jardine says) no necessity to either sew or rivet this joint, and, in consequence, the strap is not weakened by cutting away the leather for rivet and lace holes. The belt, of course,

* Paper read at Students' Meeting of the Society of Telegraph-Engineers.

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TABLE A.—Stretch n 10in. per 1,000lb.

Size.	Area.	1,000	2,000	3,000	4,000	5 000	6,000	6,500		
5in. by ¼in.	sq. in. 1·25	—	—	⅛in.	⅛in.	⅛in.	⅜in.	1½in.	6,530 broke.	Breaking strain per sq. in., 5,224.

TABLE B.

	Leather, grain side to pulley.			Leather, flesh side to pulley.			Rubber.			Gutta-Percha.			Canvas.		
	Commence to slip.	Cease to slip.	Slide.	Commence to slip.	Cease to slip.	Slide.	Commence to slip.	Cease to slip.	Slide.	Commence to slip	Cease to slip.	Slide.	Commence to slip.	Cease to slip.	Slide.
Pulley, leather-faced.	6	2½	10	3½	2¼	7	2½	1½	5	2½	1¼	3½	1¾	1	1¾
Polished iron	1½	1	9	1¼	⅜	6½	1¼	⅜	4½	⅜	½	2½	1	½	2
Rough iron	1½	⅜	3	1½	⅜	2¼	1¼	⅜	4	⅜	½	1½	1	⅜	1¼
Smooth mahogany, turned	3⅜	2¼	4	3	1½	3¼	2¼	1½	4½	2½	1	2½	1¾	1¼	1

TABLE C.

Description of Belting.	Breaking Strain per square inch Section.	Authority, &c.
Leather, British oak-tanned	5,746lb.	Tested on Salter's Test Machine. John Tullis and Son.
,, American ,,	4,974lb.	
,, Briti-h common tanned	4,243lb.	
,, American ,, ,,	2,708lb.	
,, British orange ,,	8,244lb.	
,, Best double leather 6in. belting	3,572lb.	Dr. Kirkaldy.
Cotton, Gandy 6in. 8-ply	6,811lb.	Do.
,, Leviathan	11,629lb.	Do.
Hair, Rossendale hair belt ..... 6in. × ¼in.	5,087lb.	Rossendale Company.
Hair, Rossendale hair belt ..... 5in. × ¼in.	5,224lb.	Rossendale Company.

should be run in the direction of the splice, and if this is done it is impossible for the joint to be torn up, as there is no projecting part of the belt to catch in anything.

In making the last joint in a length of belting, so as to make the belt an endless one, the conditions under which the belt is to be used must be taken into consideration. In the generality of cases this joint must be left uncemented, since occasionally it has to be undone to allow of the stretch of the belt being taken up.

Of course, in the case of dynamo-driving we generally have the belt an endless one, as the slack is taken up by moving the dynamo along its rails. Laces tanned with alum are, as a rule, used to join a belt. The lace-holes are pierced in two rows perfectly parallel with the end of the belt, those of each row facing the centre space between the preceding ones. This method distributes the strain on the holes in a fairly equal manner, and so reduces the chance of the lace holes being torn out. In making the joint, care should be taken that the ends are cut square off, or else a crook may be made in the band. There are besides this join any number of other ways. Almost everyone who has charge of belting has fixed upon one particular method which he sticks to, and which in his opinion is preferable to others.

Many mechanical devices have been invented with the express purpose and idea of superseding all lacing. Some of these connections are good, others are far from being so.

I should now like to say a few words on *leather link belting*, with the especial purpose of getting at some information from men who have had experience with it, and who have had full opportunities of knowing its disadvantages as well as its advantages. Link belting, I believe, is preferred by many engineers, for the reason that it runs perfectly true, and it is easily joined up as an endless belt without having to use laces or special fasteners. I, however, think from my own observations that a good cotton or leather belt is superior both in simplicity of working and in results. A link belt cannot be made stronger than a plain leather band of same size.

Again, the links of leather are all strung on to a metal spindle, which is always parallel to the axis of the pulley, and the surface of the pulley is curved. In plain link belting the links are all the same size, and so there is a continual straining and bending of the rivets when passing over the pulleys, so as to enable the belt to get a good grip of the pulley. As soon as the rivets have passed over the pulley they straighten out, and so some work is done in the belt itself. The power necessary to do this work of course must be supplied by the prime motor. Messrs. Tullis, of Glasgow, have considered it worth while to make the link belt arched so as to fit over the crown of the pulley, so that there is no bending strain on the rivets.

Again, the total surface of leather in contact with the pulley cannot be so great in the case of a link belt as in the case of an ordinary leather band, for between each link a certain amount of space must intervene. These spaces may be an advantage rather than otherwise in allowing the film of air which gets carried in between the belt and the pulley to escape, and so enables the leather to get a good firm grip of the iron. This idea of getting rid of the air film has been worked out in another way by Mr. Shepherd; he perforates the rims of his pulleys with a number of small holes, and thus allows the air to be driven out.

Indiarubber and Gutta-Percha Belts are now in use to some small extent, but, as far as I have been able to find out, they do not seem to have met with much success. The advantages claimed for these belts are: They are not affected by wet or steam, or changes of temperatures. The grip they get on the pulley rim is very perfect, since, by the very nature of the belt, it fits itself to all the small inequalities of the pulley. They are uniform in weight and texture, and they run very true. I noticed that Mr. Rankin Kennedy has used a gutta-percha belt on the ss. "Paula," which he has lately fitted with the electric light.

Both these kinds of belt are built up on a foundation of cotton or canvas, or some such fabric, and as yet I believe it has been impossible to get the rubber to enter into the body of this fabric; it simply remains as an outer coating. Unfortunately, any oil getting on the belt damages it, making the gum soft, and causing it to lose its hold on the backing. The rubber is also liable to get rolled off if a sudden stoppage either of the driving or driven pulley takes place—a short circuit of a dynamo would answer—and

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thus the whole belt is quite spoiled almost in a second. The edges are also liable to get frayed, and if a cut once gets into a run in the fabric it will, unless the machinery be stopped, follow the seam the whole length of the belt. Again, these gum belts can only be used for open driving, it being simply impossible to drive them crossed.

Cotton Belts.—I shall here do little more than mention that there are such belts made, as I presume that all of you have seen them and know something about them. One of the best makes belonging to this class is the Gandy belt. The tensile strength of this belting is considerable greater than that of leather. The belt gets a better grip on the pulley than leather; in fact, Mr. Gandy told me some electrical engineers have objected to it on account of its having too good a bite, since it refused to slip over the pulley as a leather belt would when a dynamo was accidentally short-circuited. The Gandy belt will not stand a temperature of 20deg. C, but within ordinary ranges of temperature it is not injuriously affected by either damp or heat. Common yellow soap should be used to keep the inner side of the belt in a proper clammy condition.

There is another special kind of belting I should like to bring before your notice; possibly some of you know it already. I must confess that about a month ago I did not know even of its existence. This is the Leviathan belt of Messrs. Hebblethwaite, of Huddersfield. It is a combination of a woven and a leather band so combined that we have the strength of a canvas or woven belt united with the good grip of a leather belt. It is practically two belts, not a double belt, bound together by copper wire sewing and rivets. The leather only acts as a cushion, and protects the woven belt from contact with the pulley. The leather band being on the inside, comes only very slightly into tension.

Of hair belts, I have next to no information; they were, I believe, used by the Brush Company at the Manchester Exhibition with very good results. They are a comparatively new departure, and as yet have not been used extensively by electrical engineers. I have here the results of an experiment carried out by the Rossendale Company on the stretching of one of their belts (Table A.)

In mentioning the Victoria belting, in a previous part of this paper, I referred to the fact that the hair side was always next the pulley. Plain leather belts, as usually made and used, are run with the flesh side next the pulley, and there seems to be a very great difference of opinion as to which is the best way of using the belt.

I have tabulated the results of some tests which were carried out at Mr. Hoyt's factory in America. (Table B.)

The first column, "commence to slip," in Table B, refers to that point where the belt is just about commencing to slip, but has not quite slipped—it is the value of $\frac{T_2}{T_1} = \epsilon^{\mu\theta}$ where T_2 & T_1 are tensions on each side of the belt. The second column, "cease to slip," refers to the value of $\frac{T_2}{T_1}$ when the belt has a good grip of the pulley, and is the condition under which belts are usually worked. The third column, "slide," gives the value of $\frac{T_2}{T_1}$ when one surface is actually sliding over the other. A distinction is made between columns 1 and 2 owing to belts being liable to stretch, and so to diminish their tension so that they will slip.

From Table B, taking the ordinary pulley surface, it is evident that a belt with grain side to pulley gives the best results; and it is a well-known fact that by running grain side next pulley the belt will transmit nearly three per cent. more power, without slipping, than it would do if it was run flesh side to pulley with same initial strain, and running at the same velocity. For this reason some engineers say, use your belts with grain side on pulleys. On the other hand, other engineers say if you do so, your belts will have short lives, as you are not using the leather as Nature intended, and are subjecting your belt to unnecessary strains. In the table you will see other surfaces are mentioned besides polished iron, but if I went into this question at all it would make this paper altogether too long.

I have compiled in Table C the breaking strain per square inch of various different kinds of belts.

I purpose concluding this short paper by reminding you that centrifugal force plays a very important part in the calculations for finding the size of belt required when run at high velocities. In driving dynamo machines we try to run at as high speeds as possible, for the reason that the output of a given machine per unit of weight increases if the speed is increased. Now, if a belt is driven at a very high velocity owing to its not being a weightless band, the effects of centrifugal force cannot be neglected. Each portion of the belt, when passing round the pulley, is subjected to a temporary circular motion and, consequently, to a certain amount of centrifugal force, which acts always tangentially to the pulley surface, and lessens the grip which the belt would otherwise have on the pulley. To counteract this force, the initial strain we put on the belt is greater, and by doing this we reduce the useful working strain which the belt will bear.

Mr. Kapp has given the full theory of this subject, and arrives at the result that for the total strain on the belt to be a minimum, the diameter of the pulley should be such that the strain due to centrifugal force is exactly half that due to the useful work transmitted by the belt.

PHYSICAL SOCIETY.—June 23rd.

Prof. REINOLD, F.R.S. (President), in the chair.

Among others, the following communications were read:—

"Note on Continuous Current Transformers," by Prof. S. P. Thompson, D.Sc. Two classes of transformers are considered—viz., *motor-generators* and *commuting transformers*, in which a two-circuit armature is fixed in a revolving magnetic field. Such a field may be produced by using a fixed gramme ring as the field-magnet, and rotatting the brushes round its commutator. The formulæ obtained apply equally to both classes. If C_1, C_2 be the numbers of primary and secondary wires on outside of armature, E_1, E_2; c_1, c_2; i_1, i_2; r_1, r_2, the E.M.F. potential difference at terminals, currents, and resistances of primary and secondary respectively, then it is shown that $c_2 = k c_1 - (r_2 + k^2 r_1) i_2$, where $k = \frac{C_2}{C_1}$, which is called the "coefficient of transformation."

Thus, the potential difference is the same as if the dynamo part had its resistance increased by $k^2 r_1$. As the currents in the primary and secondary are in opposite directions, the effective self-induction will be very small; hence, such machines can be run with little or no sparking. In a previous paper by the same author similar properties as regards self-induction and resistance were shown to exist in alternating-current transformers. From the above equation it is evident that a motor-generator cannot be made to give constant potential when supplied at constant potential, except when the internal resistances are very small; but by over-compounding the distributing dynamo the desired result may be obtained.

Mr. Kapp agreed with the author as regards motor-generators running with little sparking; but thought the great difficulty in using them commercially would be in preserving the insulation between the circuits if anything like 2,000 volts were used in the primary. He also mentioned the method of producing a rotating field by alternating currents, recently described by Prof. Ferraris and Mr. Tesla, and thought it would be preferable to the one devised by the author of the paper.

In reply, **Dr. Thompson** said that insulation could be easily maintained between the core and windings of Brush armatures, and saw no reason why it should present very serious difficulties in continuous-current transformers.

In the absence of the author, a paper **"On the Existence of an Undulatory Movement Accompanying the Electric Spark,"** by Ernest H Cook, D.Sc., was taken as read. When sparks pass between two points placed above a plate on which some powdered substance has been scattered, the particles arrange themselves in circular lines approximately concentric with the projection of the middle line joining the two points. The proximity of the lines is found to be very nearly constant for the same powder, independent of the intensity of the spark used, or the material of the plate. Different powders give different numbers of lines per inch, and mixtures, numbers between those corresponding to their constituents. A great number of substances have been tried, giving numbers between 40 and 88 per inch. These extreme numbers were obtained for chalk and silica respectively. The author has found no satisfactory hypotheis by which to explain the results. A number of photographs accompany the paper, showing the character of the figures produced.

At the meeting an apparatus made by the late Dr. Guthrie was exhibited, with which similar figures to those described in the paper could be obtained. It consists of a shallow elliptical dish covered by a glass plate. Sparks are passed between two small knobs across one focus, and powder, sprinkled on the bottom, forms into circles about the other focus.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

FOREIGN COMPETITION.

Travellers all agree that wherever they go, and whatever enquiries they make, one fashion is persistent throughout the whole world, and that is to decry home-made materials. Shopkeepers display foreign goods in their windows, and pretend their whole stock is imported. There is a weakness among poor humanity to dabble in business with anybody whose mother tongue is different to our own. The foreigner, be he Frenchman, German, Italian, American, or Heathen Chinee, gravitates towards England with his notions, proceeds to obtain provisional protection for his ideas, and sell them to the Briton. On the other hand, the Briton seems quite as eager to tempt fate and lose his money, as the foreigner is to get the money; for if the latter does not come here, the Englishmen sends to the four quarters of the globe gathering in, and paying for, all the "notions" that come in his way. It would be an easy task to make up a small directory giving the names and addresses of men in England, though neither Englishmen by birth or naturalisation, who manage to live as gentlemen, and amass considerable fortunes, simply by preying upon the gullibility of the many possessing a little money, and desirous of increasing their store at a far more rapid rate than is compatible with safety. These gentlemen exploit patents, pull the strings that make the political press to dance, organise syndicates, promote companies, and clear out with a nice little haul when allotment is made. Occasionally, their efforts lead to the launching of a good thing at an enormously increased cost, but their one success is the red flag that makes John Bull rush to the charge, whenever it is waved, ever after. No sympathy is due to those who contribute to the funds of these smooth-tongued promoters. They willingly take the bait, and gleefully pit their brains against those of the angler. If they lose, they lose with their eyes wide open, and certainly the money passes into the hands of those better able to look after number one than was the original possessor. The only regret is that a certain amount of capital that might have been expended usefully is probably lost to the country. The case is but another example of the Greek spoiling the Turk. There is another phase of competition which probably hits our own business men, whether they be manufacturers or distributors, harder than any other. Take any piece of apparatus—electrical or otherwise—made in large quantities in England, and equally well, say, in America. Our own business men complain, and complain justly, that there exists a class of men who accept pay from the foreigner, cry up his wares to an admiring public, and pave the way for him to gain a good footing in the English market. It is exceedingly difficult to specialise any case, but no doubt every reader will be able to find an example for himself.

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In many cases no doubt our manufacturers have to thank their own supineness, and nothing else, for competition that threatens their extinction. Let us take one simple example. Almost everybody wears a watch, and electricians have to undergo the troubles attendant upon their watch becoming magnetised. American watchmakers provided against this, and produced watches which are uninjured by proximity to large dynamos. They are always directing attention to these manufactures, but, with perhaps one or two exceptions, and these at rare intervals, what English watchmaker troubles himself upon the question? Because he is unable to gain the ear of the profession and induce orders at once, the Englishman is content quietly to drop behind in the race, and allow his rival a field in which to work at his leisure. The one case we have referred to is among the least important directions of competition. We have called attention to this phase of business because there seems to be a tendency in some quarters to ignore our own manufacturers in the case of all that pertains to the transmission of power, and strong efforts are being made to bring in systems connected with tram work which, if not altogether unsuitable, are not so good as can be had at home. It is certain that neither with overhead, underground, or accumulator systems is there anything abroad that is superior to what is well known at home. This fashionable craze for imported goods has led to great loss of time and money, and is likely to lead to greater losses; but so far as electrical work is concerned, we really ought to be raised above that sphere of ignorance that leads to those mistakes, and be sufficiently acquainted with the work to trust the ability and knowledge of our own engineers.

TELEPHONY.

According to the report of the United Telephone Company's meeting, an abstract of which is given elsewhere, the shareholders are becoming inconveniently clamorous for certain information. They are beginning to realise that the most profitable position in the company is that of a director, and that, while the directors are paid to the tune of nearly £10,000 a-year, the shareholders are looking forward, not to the continuation of good dividends, but to the possibility of their company being swept away by the action of the Government. The answer of the directors to the criticisms of the shareholders was practically this: "You are not behind the scenes—we are; and being so, know our policy to be the correct one, and that which you advocate a dangerous one." This answer upon the face of it is a good one, and, to a certain extent, unanswerable. No doubt the policy of the directors has led to a good dividend, and has increased the value of the shares till they stand at a very high premium; but the shareholders evidently feel an insecurity of tenure in the future, and it is this inability to see what may happen that is creating alarm. In reply to the remarks about call offices and the increase of such offices elsewhere, the directors stated that the principal returns were from the exchanges; that they desired to interfere as little as possible with the exchange or with their constant subscribers. There was, however, little notice taken of the accusation that the subscription was too high, and that it would be far better to lower the tariff to induce every householder to be upon the exchange rather than continue the exclusive rates as now imposed. We quite agree that the management of the Telephone Company is not what it should be, and that the shareholders have great cause for feeling insecure. With regard to the consideration of subscribers, the management might take a leaf out of the history of railway management. From the time that the comfort of the passengers was more carefully considered, the rise in value of railway securities has continuously increased. Those lines that cater least for comfort are those that are patronised the least. We contend that the criticism of the shareholders is both just and logical, and that the revenue of the company would be increased by leaps and bounds if the requirements of business and home life were more considered. If the statement is correct that at certain periods of the day the exchange work is almost more than can be managed, it speaks volumes for the incapacity of the management. There should be a very large margin for development, and no trunk line and no system of lines should be erected without due provision being made for such development. More than once we have ventured to differ about the management of the company, and it is highly satisfactory to find the shareholders awakening to their position.

CORRESPONDENCE.

THE BRITISH ASSOCIATION OF MEDICAL ELECTRICIANS.

To the Editor of The Electrical Engineer.

Sir,—My attention has been drawn to your note headed "Medical Electricity," which appeared in last week's issue of *The Electrical Engineer*, on page 601, Vol. I.

I am pleased to notice you mention the fact that "The British Association of Medical Electricians" is in no way connected with "The Institute of Medical Electricity, *Limited*"; but the other statements contained in the paragraph referred to are entirely incorrect and misleading. You have evidently been misinformed either by a person or persons having a pecuniary interest in "The Institute of Medical Electricity, *Limited*," or by some of the Medical Battery Company's discharged servants, who, out of spite and jealousy, wish to try and damage our association because Mr. C. B. Harness, their late employer, has been elected president.

I am surprised that your paper should lend itself to such petty manœuvres. Surely, in justice to our association, you should have obtained authentic information on the subject before making such grossly inaccurate statements.

The British Association of Medical Electricians is *not* formed for commercial purposes, as you state, and none of

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its members can receive any portion of its funds. I enclose herewith a circular, from which you will see that our association is formed purely for the investigation and development of medical electricity, and all the funds of the association will be devoted to that purpose. The "Institute of Medical Electricity," on the contrary, is a *limited* company, formed purely for commercial trading as a financial speculation, although the public have, to some extent, been misled by the *eminent* "A.S.T.E.," Mr. H. Newman, Lawrence, writing letters to the press, and carefully omitting the word "limited" after the name of the company, contrary to the Limited Liability Act.

I hope you will be good enough to insert this letter in your next issue, so that the few facts I have stated may be known to your readers.—Yours, &c.,

H. C. SHARMAN, Secretary.

39, Hatton-garden, London, E.C.,
July 3, 1888.

The following extract from the articles of association has been sent with the above letter:

"The objects for which the association is formed are to promote and encourage the study and practice of medical electricity, for which purpose facilities will be afforded for the reading of papers, the delivery of lectures, the prosecution of experimental research, and the free interchange and publication of ideas and experiences of those who are engaged in the study or practice of medical electricity, and in the investigation of allied sciences. To encourage those who recognise the claims of these questions to their serious consideration, as well for their scientific interest, as for their practical importance as a department of the healing art. To maintain the honour and interests of the medical electrical profession by the aid of all or any of the following:—

"(*a*) Periodical meetings of the members of the association and of scientific men and others interested in the study of medical electricity;

"(*b*) By the publication of such information as may be thought desirable in the form of a circular or journal, or by reports to be published in existing independent periodicals;

"(*c*) By the occasional publication of transactions or other papers;

"(*d*) By the grant of sums of money out of the funds of the association for the promotion of the medical, electrical, and allied sciences in such manner as may from time to time be determined on;

"(*e*) And such other lawful things as are incidental or conducive to the attainment of the above objects."

THE ELECTRIC LIGHTING ACT.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—We beg to enclose you copy of letter addressed by Lord Thurlow to the members of the executive committee of the Electric Lighting Act.—Yours, &c.,

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION, LIMITED.

Belvedere-road, Lambeth, S.E., July 3rd, 1888.

Sir,—In thanking you for the valuable support and assistance you have extended to me as Chairman of the Electric Lighting Act Committee, without which support it would have been useless for me to have attempted to move in the matter, it affords me great pleasure to inform you that the Bill amending the Act of 1882, framed on the lines recommended by your committee, and introduced by me into the House of Lords this year, has now passed both Houses of Parliament without material modification, and only awaits the Royal assent to become law.

Under this Bill, 42 years are substituted for 21 as the life of a provisional order, and 10 years for seven for that of a license; more favourable conditions are also prescribed in the event of compulsory purchase by a local authority at the end of the term.

I sincerely hope that this successful termination of our efforts during the last three years may render it possible to attract the necessary capital to enable the electric lighting industry to advance without further delay on its career of utility, beauty and economy.

My own opinion is, that with the alterations in the Act now effected, and with good management, no reason exists why electric light undertakings should not now prove commercially and financially successful, and become a well recognised investment for capital at least as profitable as gas shares, or other equally popular securities.

With reference to our committee I should propose that it be not dissolved, but continued in existence, so that it may from time to time be called together for deliberation and consultation as occasion may require. On this point I shall be glad to have the benefit of your opinion.—Yours, &c.,

THURLOW.

26th June, 1888.

DISCLAIMER.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—In the list of patents in the current issue of your journal you cite the Patent Application No. 8,920[88] as if I were the inventor. Kindly note that the name of the Société d'Exploitation des Câbles Electriques should appear in this, as in the immediately preceding application. My position in the matter is simply that of patent agent, not inventor.—Yours, &c.,

J. G. LORRAIN.

Norfolk House, Norfolk-street, Strand,
London, W.C., July 4, 1888.

[It will be found that the Official Journal does not always give such details as are furnished by our correspondent. Thus, Specification No. 9,264—referred to in our list this week—is given in the Official Journal as of Mr. J. G. Lorrain.—ED. *E. E.*]

MR. J. W. SWAN'S GARDEN PARTY.

A garden party was held in the grounds of Mr. J. W. Swan, M.A., at Lauriston, Bromley, Kent, yesterday afternoon, at which a large number of scientific men and a large proportion of ladies were present. *Réunions* of this kind are exceptionally interesting from the fact that many of the most recent applications, especially of electrical science, which to ordinary persons are matters of scientific interest only, or at most of knowledge only through rumour, hearsay, or description, are here seen in actual presence. No small pains had been taken to have some of the latest novelties in electric science, which we shall presently describe, as well as—for the ladies—those of social interest, in the shapes of the renowned American whistling lady and other musical delectations.

Mr. Swan's house, as our readers are probably aware, is itself very beautifully fitted throughout with the incandescent electric light, and constitutes a sight of very considerable interest and beauty. The living rooms are fitted with daintily-tinted electroliers, supplied by a dynamo, gas-engine, and accumulators in an outhouse near. The grounds are lighted with large incandescent lamps of 500 c.p., making the whole garden at night clearer than moonlight.

THE ENGINE-ROOM

was thrown open, and was the centre of a great deal of interest. The dynamo is a unique type, of Mr. Swan's own design, probably as perfect a machine as it is possible to make. Its field-magnet is one huge ring of soft iron, on which flattened rings of insulated copper tape are separately slipped, soldered together on connection at the top. This arrangement allows radial spaces round the outside of the field-magnet, which by this means remains probably cooler than any other type of machine. In the engine-room a small motor was arranged, lent for the occasion by Messrs. Immisch and Company, which, mounted on a pedestal, was made to drive the lathe in the laboratory adjoining, the current being obtained from the battery of accumulator cells. The running of this powerful, but diminutive, motor excited a good deal of interest; an explanation was appended, indicating how mechanical motion was obtained by the continual chasing round and round by the poles after magnets which they could never catch.

PROF. ELIHU THOMSON'S METHOD OF ELECTRIC WELDING.

The attention of engineers and electricians has been directed during the past few months to the system of

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electric welding invented by Prof. Elihu Thomson, of Lynn, U.S.A., and at present most successfully worked in the States by a Boston company. One of the most noticeable features was a specimen apparatus of this welding process, which was lent for the occasion by the agents of the Thomson-Houston Company in England—Messrs. Laing, Wharton and Down—previous to its instalment at the Italian Exhibition. The alternating dynamo which supplies the current for the transformer (the whole being on one stand) was driven by a portable steam-engine fixed in the garden. The principal feature of Prof. Thomson's apparatus is the large coil of fine wire surrounding one single coil of very thick copper, by means of which arrangement a comparatively small current at a high pressure is transformed into an enormously large current at a low pressure. A popular description of this welding apparatus was appended for all to read, giving a general idea of how the heating effect of a large current was used to fuse the metals, which are pressed together by the action of the apparatus; the certainly interesting statement was thereon made, that for the short period of a second or two during the making of a large weld, the current required is equal to that carried by 10,000 ordinary incandescent lamps, though the pressure used was only $\frac{1}{100}$th of that ordinarily used for lighting.

Without going deeply into details of the theory of the process, the scientific principle involved and practical method of working the electric welding apparatus may be briefly described as follows:

An electric current flowing through a circuit generates heat at every portion, and the higher the resistance of any part of the circuit, the more the heat generated at that part. Therefore, if an electric circuit of otherwise almost inappreciable resistance be completed by the slight contact formed by the abutment of the pieces to be welded, upon the passage of a sufficient current through the circuit this point of contact may be speedily brought to a welding heat, and, by a suitable pressure, may be firmly united when at this heat. In practice, the pieces to be operated upon are tightly held by clamps, which hold the pieces in correct relative position, and may also serve to conduct the current into the pieces. Both the current and pressure can be delicately regulated, with the result that all pure metals, most alloys, and many combinations of dissimilar metals, can be united.

The value of the process will be easily seen, since it is possible, without the aid of the forge fire, and with a minimum of time, labour, and expense, to form perfect welds between almost all sizes and shapes of metals. The system of electric heating is also free from the impurities of the ordinary forge, and the heat is easily localised at any desired point. This is important in the welding of high grades of steel, since the metal is not impaired, nor is the "temper" withdrawn, except directly at the weld. The same source of heat may be employed for retempering or annealing by any of the ordinary processes.

The applications of the process in practical work are almost limitless, but the following rough classification will present some of the more important uses:—

(*a*) The joining of wires for cables, electrical work, and other purposes.

(*b*) The joining of solid bars and rods of all shapes. This would be important in bridge work, in the formation of long lines of shafting and rails, in working angle iron and the making of "T" and "Y" joints, in the shortening or lengthening of tools, rods, &c., for particular purposes; in the making of tools where a hard steel, employed for the cutting edge, could readily be joined to a milder steel or iron; in all sorts of general repair and construction work.

(*c*) Chain and link work: Making links of all shapes and sizes. Employing steel in place of iron for chains, and thus obtaining a chain of maximum strength for a minimum of weight; also in the formation of ornamental chains of any precious metal or combination of metals.

(*d*) Pipe work: The forming of continuous lines of piping without screwed joints; also in plumbers' work. The longitudinal welds of large piping and boiler flues could be readily welded by the electric process.

(*e*) The welding of rings, hoops, and tins would offer a large field for the process. Welds could be effected in those places where the ordinary method would prove too coarse, and where riveting and brazing are now substituted for welding.

(*f*) The local heating of metals for tempering, annealing, bending, shaping, &c.; also for raising solid collars upon shafts, axles, &c. A most important application will be had in the heating and heading of bolts and rivets at a single operation.

(*g*) The substitution of the electric heat for brazing and soldering in place of the blowpipe, as being more speedy and economical than the latter method.

While this process is particularly fitted for special work, a welding apparatus with adjustable clamps for holding all shapes of material would be invaluable for general use in the workshop.

Numerous tests have proved that the weld in all cases is most satisfactory, and generally of equal strength with the original solid metal.

The cost of welding by this process is much less than that of the ordinary forge-fire method, nor is a knowledge of electrical laws nor skilled labour required. The working of the welding machine is absolutely without danger to the operator.

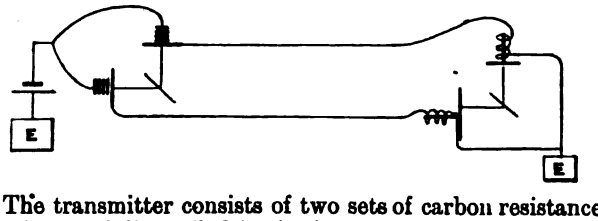
The above-mentioned applications give but slight idea of the vast fields for the process, and new uses may be found in nearly every workshop.

It may not be unreasonable to suppose that in time the largest shafts, boiler-plates, &c., will be united by this electric method, and that the new invention will grow in utility and general use as has the electric telegraph, and more recently the telephone and electric light.

Numerous specimens of welding on different metals from $\frac{1}{16}$th to 1in. thick were shown.

Robertson's Writing Telegraph.

Another point of universal interest was the writing telegraph, which was worked and explained by Mr. Johnson Stephens, who is acting as agent in England for the Writing Telegraph Company, of 46, Holborn-viaduct, who kindly lent the instruments for the occasion. This instrument reproduces the actual handwriting of the person sending the telegram, and is expected to be largely used instead of, or in conjunction with, the telephone for general uses, and especially for messages which require documentary evidence. The principle of the writing telegraph is dependent upon the possibility of analysis of the motion of writing into two separate motions—one an up-and-down motion, and the other a backward-and-forward one. These motions which are combined in the various curves in the act of writing, are separated into the two motions by the movement of a stylus acting upon two arms at right angles in the instrument, which are made to send two currents of varying intensity through the wires, producing separate movements at the further end, which are reunited, thus reproducing the facsimile of the original curves. The credit of the first application of this analysis into two motions and their subsequent synthesis at the further end has been given to Mr. Cowper, in England, but in his apparatus separate resistances were used which, varied by the action of the stylus, produced a number of step-like motions which approximated to curves. The action was of course disjointed in the same manner that Reis's telephone was, and the method that was independently invented and brought to perfection by Mr. J. Hart Robertson, in America, differs in exactly the same manner from Cowper's as Bell's telephone does from Reis's. Indeed, the whole action of the writing telegraph can best be studied from the point of view of the telephone, and can be readily understood from the accompanying diagram:—



The transmitter consists of two sets of carbon resistances, consisting of discs piled in the form of a rouleau, like coins, in small boxes, and fixed at right angles to each other. Let it be granted that, in the manner of the telephone, any

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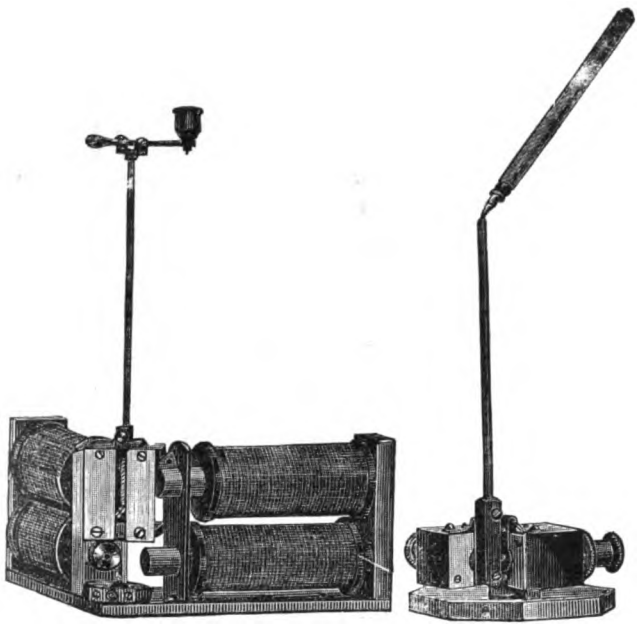
vibration on the tympanum of one of these boxes, by varying the resistance of the carbon discs, alters gradually the strength of an electric current passing through them, and, by acting upon a magnet at the further receiving end, reproduces the vibration produced at the transmitter. The

Specimen of writing.

same effect is produced in the second set of resistances and receivers. If the two motions are combined by an action pulling upon the membranes at the same time, the result upon the two receivers likewise combined will be a series of lines, curved or straight, according to the pull of the levers. Any curve that is made, therefore, at the transmitting end, will be resolved into its constituent movements by the arms of the two membranes, and can be made to transmit distinct and varying currents along the lines. These can be received by the two magnets acting upon similar membranes at the further end, and recombined into the original curves by the stylus. This is, in effect, the action of the writing telegraph. The parts of the writing telegraph are shown in the accompanying illustrations. The transmitter consists of a pencil or stylus fastened to the long lever arm by a ball and socket joint to allow of motion in any direction, and to accommodate itself to the hand. This lever projects slightly through the box. Motions are made with the stylus as if in writing letters, which cause pressure of more or less degree to be made on the carbon resistances below, and varies the current in the lines in like degree.

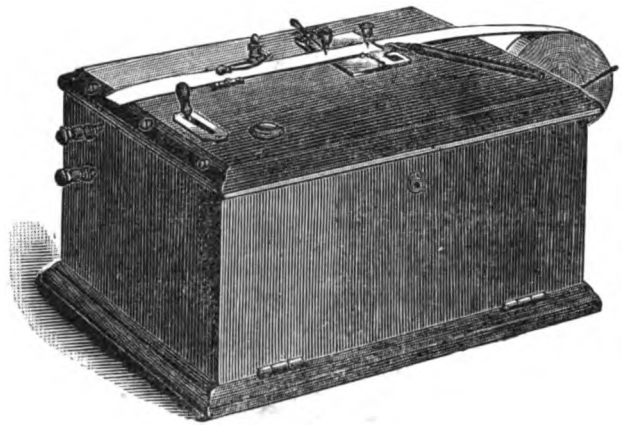


Receiver. Writing Telegraph Transmitter.

Of course, as this stylus is fixed to the lever, the motion cannot be extended far to the right as is usual in writing; the writing is done as if one were writing in the air. The receiver of the same instrument is in circuit, however, and the strip of paper, as it passes along from left to right, reproduces the motion of the writer, who can thus see before him what he has written.

At the other end of the line the currents are received by two electro-magnets placed at right angles; these act upon an armature pivoted at one point, and having a long lever arm carrying a fountain pen. The combined action of the two electro-magnets upon the armature reproduces the motion of the stylus from the other end. The appearance of the instrument exhibited is seen in the cut.

It was at first thought necessary to use two batteries, one for each transmitter, but it has been found by Mr. Stephens to need only one, and, in fact, to work better with one than two. The number of carbon discs employed is usually about twenty; the resistance can be easily varied by these from 2 to 200 ohms. The usual instruments are made to work on a double five mile circuit, which would be about right for ordinary exchanges—that is, five miles from each instrument to the exchange. For exchange use it is not necessary to have separate batteries; all the battery power would be at the central station. A switch is provided to put it into condition for either receiving or transmitting, and this is usually left at "Receive." On moving it, a small Leclanché battery at the central would put it into circuit; the number required can be transmitted to the attendant at the central, who then by a current starts the other person's receiver, and the message can be received even if



The Writing Telegraph.

no one is there, which is not, of course, the case with the telephone. A rough clock movement released by a detent works the paper-carrier. The message can be run off automatically into a locked receptacle to await the owner's return.

As the alternations of current are very gradual compared with those of the telephone, the writing telegraph can be duplexed upon the telephone wires without in any way interfering with the speaking qualities of the telephone. As the messages are in exact fac-simile of the original writing, and are, in fact, as much the original writing as that in the writer's own office, they can be accepted as proper documentary evidence, and for this purpose will have equal value with ordinary letters. For the transmission of club and Stock Exchange news it would prove most useful and simple. The receivers, arranged in series, could all be actuated by one transmitter, and the parts needed for each receiver would be simply the two magnets and lever arm with pen, and the clockwork movement, which all could be set in motion from the one office.

Several small improvements have been made in the action of the pen since first exhibited, and the method of application in exchange use more fully developed.

Pollak's Arc Lamps.

A simple arc lamp, actuated by the variations in length of a wire heated by the current, was exhibited. This lamp

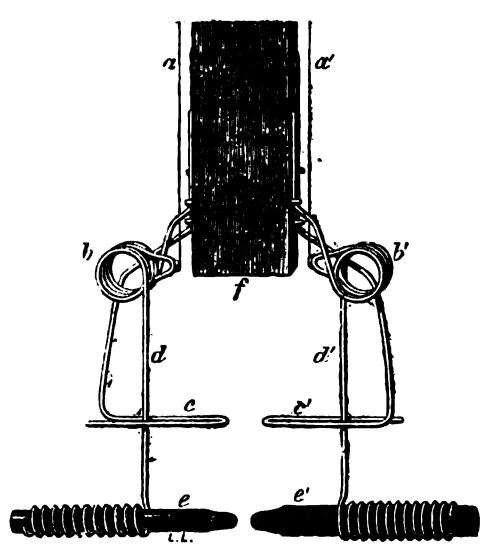


Fig. 1.

is known as the Pollak lamp. Fig. 1 shows the first apparatus of the kind, and will easily be understood from the illustration: $a\ a^1$ are brass wires, from ·4 to ·5mm. diameter,

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intended to carry a current of 5 amperes. One end of the wire is fixed to the spirals, b b^1, which are continued in the straight pieces, d d^1, which again take the spiral form, acting as carbon-holders, e e^1. The expansion and contraction of the wires, a a^1, acting at the end of a lever, as shown, increases or decreases the length of the arc. In Fig. 2 the wires, a a^1, similarly act at the ends of levers

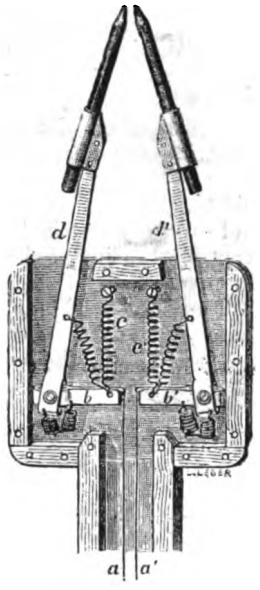

FIG. 2.

and against the action of springs, as shown. The form of lamp exhibited was the simpler one, the most recent is a much more elaborate affair.

RAUB'S THERMO-BATTERY.

One of Raub's new thermo-batteries, of which we have given some description in preceding numbers, was fixed in the laboratory in place of the gas stove removed. The battery has much the appearance of an ordinary stove on a bracket, and is heated from below with Bunsen burners, part of the heat being converted into electricity, and the remainder serving to heat the room. The second or middle size of thermo-battery was shown, giving a current of 20 amperes, when the external resistance is equal to the internal, and having an E.M.F. on open circuit of 3 volts. The internal resistance of the battery is 0·06 ohm. The novelty of this battery consists in the application of ring-shaped elements, made a hollow core for the flame, instead of alternate blocks and strips as in earlier forms, together with the employment of the heated air to draw up cool air round the outer terminals of the thermopile. The elements are made of a zinc-antimony alloy, and of German silver alternately. Mr. Swan had sent over to Berlin for a specimen of this thermo-pile specially for the occasion, as the greatest advance in this department, and shown as interesting on account of the strength of current obtained, which is considerably in excess of any hitherto produced by means of gas burners. Mr. Swan looks forward to some such combination of heating apparatus and electric thermopile for charging accumulators for the house lighting, as possibly "not only useful, but even economical."

An earlier form of thermo-battery—that of Noë—was also shown, in conjunction with a small incandescent electric lamp. This battery has three large gas-burners, and the current produced lighted the lamp, which was mounted on a stand and connected to the battery by a flexible wire, and gave, when fully in action, about 5 c.p. It was interesting to note the continued action of the thermopile for some considerable time at full power after the gas has been turned off by the utilisation of the heat already given, a kind of kinetic energy effect in the heated particles of the pile.

MINERS' LAMPS.

The specimens of Mr. Swan's latest types of miners' electric lamps were examined with much interest. These consist of a set of small storage cells, in conjunction with a special small incandescent lamp inserted under a bullseye. The lamp itself is out of all contact with the air, and cannot cause an explosion. It is thus a true safety lamp.

PROF. LODGE'S DUST SETTLER.

A small piece of apparatus was exhibited in connection with a Wimshurst influence machine, which has excited a great deal of attention. This was Dr. Oliver Lodge's dust settler. In the small experimental primitive form shown it consists of a glass receiver, having two rows of brass spikes arranged inside and opposite each other. Below is a compartment where brown paper or magnesium wire can be burnt to generate a thick smoke, which fills the whole glass receiver. On turning the handle of the Wimshurst machine the dust particles rapidly settle, leaving the air quite clear, by the electrification of the smoke particles.

This method of causing dust to settle, exhibited first in this small form, has already had its practical application in mills, where dust abounds, and it has been found useful in the ordnance departments, where the dense smoke after firing heavy cannon in a confined compartment, which often renders everything invisible for many minutes, can be settled by a few turns of an induction machine. It might certainly, it is suggested, be worth the while of the great Mr. Augustus Harris to introduce several of these machines into the Drury Lane Theatre before next November, so that inside, at least, the air might be made clear by the silent discharge of electrified points, even while outside all London suffered from a "pea-soup" fog.

THE PARTY.

The weather, always a momentous point in an English garden party, had been anxiously watched for days previously, fearful lest the occasional storms and downpours should put a damper upon the festivities. A severe downfall came on in the morning, and throughout the weather was very variable, but the gathering was extremely enjoyable. The sombre and scientific unbent in inspecting the many practical equipments provided for their interest, and in explaining and showing forth the wonders of electricity to the fair visitors, who wondered when the result of all these applications should likewise be brought to their own doors.

A STUDY OF CERTAIN ERRORS IN THE CONSTANT SHUNT METHOD.*

BY WILLIAM L. PUFFER, S.B.

A very neat and valuable application of Ohm's law is that usually called the shunt method for the determination of current. The method is described in the Munich, Vienna, and Philadelphia reports on dynamo tests, as well as in the *Electrician* and *Electrical Engineer* for January, 1885.

The principle is this: If a conductor of constant unknown resistance be placed in a circuit, and currents of different strength passed through it, there will be a difference of potential at the terminals of the conductor proportional to the currents flowing; and if this conductor be placed as a shunt upon a reflecting galvanometer whose resistance is high as compared to the conductor, and whose deflections are proportional to currents producing them, then the deflections will be proportional; first, to the currents in the galvanometer circuit; second, to the potential difference in the conductor: and, third, to the currents in the conductor.

In order to extend the range of the apparatus, the galvanometer deflection can be kept the same by changing the total resistance in its circuit; then this total resistance is also proportional to the potential difference in the conductor. In order to save time, the galvanometer deflection may be nearly the same, and the product of the deflection and corresponding total resistance taken; these products will then be a measure of the corresponding currents in the conductor. If a known current be passed through this conductor or shunt, and the galvanometer deflection and total resistance of the galvanometer circuit multiplied, and the product divided by the known current expressed in amperes, we get the constant of the apparatus for amperes. To find value in amperes of

* Read at the meeting of the American Academy of Arts and Sciences January 11, 1888.

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an unknown current, we have only to note the deflection and total resistance in galvanometer circuit, multiply them, and divide by the constant. Or we could divide the known current by the product of resistance and deflection, and get a constant by which to multiply the resistance and deflection obtained with the unknown currents.

The range of the method is very great, and is, perhaps, limited only by the difficulty of making a suitable shunt of such a cross section as to be free from injurious heating by the currents used.

Wishing to employ this method in the Roger's Laboratory of Physics in a slightly different way, requiring that the shunt resistance be known, I made some experiments to determine the resistance of a German silver rod, 3ft. long and 0·6in. in diameter, with the intention of using it as a constant shunt of *known* resistance for currents from about 1 to 60 amperes. An inch from each end a small wire of German silver was silver-soldered in a hole drilled nearly through the rod, and the lead wires running to a low resistance galvanometer were connected by screw-clamps. On the ends of the shunt were soldered brass screw connection for insertion of the main wires.

A standard ohm was placed in circuit with the shunt by means of mercury cups, and the resistance of the shunt found by comparison of the potential at its terminals with that at the terminals of the ohm, using a Hartmann dead-beat galvanometer and resistance box as usual with the shunt method.

The results were very unsatisfactory, although care had been taken to prevent, as far as possible, any error due to change in temperature, by placing both the shunt and the standard ohm in a water bath, and noting the temperatnre both before and after a set of readings.

As the observations were taken in a short time, and the resistances measured immediately afterwards, it is not probable that there could have been any noticeable change during the experiment.

With the shunt in water, the results checked within about 0·3 per cent., the highest being 0·00 085 39, and the lowest 0·00 085 10 ohm. When the shunt was in melting ice the results were more variable, and in air very bad. A careful test of the wires and connection showed that when there was no battery in circuit there was a variable E.M.F. in both the galvanometer circuit and in the shunt itself sufficiently great to account for the errors in previous work.

The error in the galvanometer circuit was avoided by greater care in manipulation and the use of a mercury commutator; but the shunt proved so troublesome that a study of the nature of the small, disturbing E.M.F. force observed seemed desirable.

As this error, which I attributed to thermal action, was entirely negligible in the standard ohm because of the comparatively high difference of potential produced by the calibrating current, I thought that a German silver shunt, capable of carrying 5 to 10 amperes, having a resistance of from 0·1 to 0·2 ohm, might be compared with the ohm, and then with the shunt, without any appreciable error from heating or thermal action.

The following is a brief description of the shunts made, and the arrangements for taking observations and avoiding errors:—

The large German silver shunt has already been described. The standing German silver shunt was made of a 50ft. length of wire of ¼in. diameter, drawn to order, and of the quality known as "18 per cent." A short length of No. 14 German silver wire was looped around this shunt near each end and silver-soldered to it, using borax as a flux, and similarly a set of copper wires as well, thus giving me virtually two shunts of the same resistance and material, differing only in the metal wires used for the potential leads. The shunt wire was doubled and bent back and forth through porcelain insulators fastened to a piece of board. Also, a copper shunt was made of two pieces of No. 00 wire, each 11ft. long. These were connected by being soft-soldered into a brass block, using resin as a flux, and then coiled in the same directions, to avoid magnetic disturbance, and suspended from ebonite supports in a stone jar. At three places on this shunt—near each end, and in the middle near the brass block—were soldered a set of four wires. Each set of four contained a German silver and a copper wire, silver-soldered with borax, and a similar pair soft-soldered with resin. This was equivalent to twelve simple copper shunts, with different leading wires and solders.

Each of these three shunts was placed in a tank of water provided with a thermometer. The potential wires were carried to mercury cups and commutators on a table thirty feet away, where the resistance boxes were placed.

The galvanometer was a double-coil Hartmann, with bell magnet and copper damping-block; the deflections were read by a telescope and scale at a distance of 3·68 metres.

The galvanometer wires were soldered to amalgamated brass rods, held in a piece of ebonite provided with a long handle, used in changing the connection from one set of wires to another.

In order to avoid temperature correction, the shunts were placed in water and carefully watched until it was evident there was no perceptible heating of the water or wires by the current. A loop of the galvanometer leads was always connected to a Wheatstone bridge used to measure the resistance in circuit. There was never any change large enough to cause any trouble, as the measurements were all taken in a short time, and the rise of temperature was very slow.

The deflections were always brought to about 10 double centimetres each side of the middle of the scale, and were written 1,000, calling the tenth of smallest division unity. Within the limits of the scale the proportionality of the deflections was nearly perfect, and quite so within the limits of working. The error due to change in length of the suspending fibre was studied, and found to be negligible only when the precaution was taken to compare a mark on the mirror with a mark on the metal frame of the instrument, and adjust the height of the mirror to 0·1 or 0·2 millimetre. The torsion of the fibre was negligible in the range of deflections used.

The galvanometer and its connecting wires had a resistance of 4·7 ohms, and was used as a voltmeter for measuring the thermal E.M.F.'s with an accuracy of about 5 per cent. The factor 0·00 000 040 was used to multiply the deflections by in order to obtain the thermal action in volts, when no resistance other than the galvanometer and connecting wires was in circuit.

It was assumed that these shunts would be calibrated with a current of 1 ampere, and that an accuracy of 1 part in 1,000 was desirable. The table gives the resistance of the shunts, and also the volts corresponding to an error of 0·1 per cent. of the difference of potential caused by a calibrating current of 1 ampere. These small E.M.F.'s are represented by two units of deflection of the voltmeter in the case of the copper and the large German silver shunts, and 2,000 with the standard shunt.

	Resistance in ohms.	0·1% P.D., due to an ampere.
Large German silver shunt	0·00 085	0·00 000 085
Standard German silver shunt.....	0·16	0·00 016
Half of copper shunt.....	0 00 070	0·00 000 070

The large G. S. shunt in air often showed from 1 to 3 units deflection, sometimes in one direction and sometimes in the other; but when placed in water this error was reduced to a much smaller amount, and seldom could be detected. At one time there seemed to be a variable deflection, which was traced to the contacts in the screw connection used to join the galvanometer leads to the shunt wires. This was easily removed by bending the wires until the clamps were under water. After this I could never detect any deflection caused by thermal action in this shunt, although owing to the low resistance of the shunt an error of 0·05 per cent. would cause so small a deflection that it might pass unnoticed.

The copper shunt, with its different terminals, proved very interesting, and exhibited a great variety of thermal action which would in many cases be too large to be neglected if the shunt was to be used for comparison of currents.

(To be concluded.)

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LEGAL INTELLIGENCE.

SWABY v. WATT AND OTHERS.

In the High Court of Justice, Chancery Division, on the 29th ult., before Mr. Justice Stirling, the case of Swaby *v.* Watt and others was disposed of.

The plaintiff in this case was a director of the Maxim-Weston Electric Company, and he moved the Court that the defendants might be restrained—(1) from forfeiting or cancelling 400 shares in the capital of the Company held by him; (2) from allowing any notice, minute, or entry alleging such forfeiture or cancellation to remain on the register or in the minute-book of the Company; (3) that the defendant Howell might be restrained from acting as a director of the Company; and (4) that the defendants might be restrained from excluding the plaintiff from meetings and from interfering in any way with his acting as a director of the Company. The defendant, Mr. Hugh Watt, M.P., was the chairman of the Company, and the defendant, Mr. George Howell, M.P., claimed to have been duly appointed a director. The facts of the case appear sufficiently from the judgment.

Mr. W. Pearson, Q.C., and Mr. Gazdar appeared for the plaintiff; Mr. Graham Hastings, Q.C., and Mr. Alexander Young for the defendant Howell; and Mr. Buckley, Q.C., and Mr. Robert Wallace for the Company.

Mr. Justice Stirling, in giving judgment, said:—"The evidence adduced in this case shows that some very singular transactions have occurred in this Company. In the first place, the plaintiff, who is a director of the Company, asks to be relieved from an alleged forfeiture of his shares, and that alleged forfeiture is certainly the most curious that I ever heard of. It is provided by Article 23 of the Company's articles of association that—'If any member fails to pay all or any part of any call or instalment on or before the day appointed for the payment of the same, the Directors may at any time thereafter, during such time as the call or instalment remains unpaid, serve a notice on him requiring him to pay the same, together with any interest and any expenses that may have accrued or been incurred by reason of such non-payment. The notice shall name a further day (not less than 14 days from the date of the notice) and place or places on and at which such call and instalment and all interest and expenses that have accrued or been incurred by reason of such non-payment are to be paid. It shall also state that, in the event of non-payment at or before the time and at the place appointed, the shares in respect of which such call was made or instalment is payable will be liable to be forfeited." And Article 24 provides that—"If the requisitions of any such notice as aforesaid are not complied with, any shares in respect of which such notice has been given may at any time thereafter, before payment of all calls or instalments, interest, and expenses due in respect thereof, be forfeited by a resolution of the Directors to that effect."

It appears that disputes having occurred between Mr. Watt and Mr. Swaby on March 19, 1888, the solicitors of the Company wrote the following letter to Mr. Swaby:—"We are instructed by the Maxim-Weston Electric Company, Limited, to apply to you for payment of 5s. per share on the 2,000 shares which on your application were allotted to you in October, 1886. And we have to acquaint you that unless the amount be paid to us, together with interest at 10 per cent. per annum from the time when the respective calls became due, proceedings will be taken against you for the recovery thereof and without further notice to you."

Now that, continued his Lordship, was not in any way a notice in accordance with Article 23. It no doubt required him to pay the instalments alleged to be due, but it did not name a further day upon which such payment was to be made, nor state that, in the event of non-payment, the shares would be liable to be forfeited. But the further proceedings were even more extraordinary still. The letter of the 19th of March related to 2,000 shares, but Swaby denied that he was the owner of those shares. That was not seriously contested. It appeared that they were allotted to him in October, 1886, and on the 21st of February they were transferred to Watt, and this notice was not given until the 19th of March, 1888—more than a year after the transfer. In addition to the 2,000 shares, Swaby was also entitled to 400 fully paid shares. Now, by the articles shares were only forfeitable if the member holding them failed to pay calls on the day named. These 400 shares being fully paid-up, it was difficult to see how they could be forfeited at all. But on the 6th of April, 1888, this minute appeared in the minute-book of the Board of Directors:—"The solicitors of the Company reported that Mr. Louis Swaby had paid nothing with regard to the 2,000 shares applied for and allotted to him as against principal, interest, or damages resulting from non-fulfilment of contract, and it was resolved that the 400 shares standing in his name in the register of the Company be and they are hereby forfeited, and that intimation be accordingly sent to Mr. Swaby informing him that, as he is no longer a shareholder in the Company, he is neither entitled to act as a director nor to have the privileges of a shareholder." And on the 9th of April the Secretary of the Company wrote to Mr. Swaby as follows:—"I am directed to inform you that your 400 shares have been cancelled for claims due by you to the Company, owing to non-payment of the 2,000 shares applied for and allotted to you, and against which you have paid neither principal nor interest. You having accordingly ceased to hold any shares in this Company, are neither entitled to act as a director nor to the privileges of a shareholder."

It appeared also that there was an entry in the register of the Company opposite to the 400 shares to the effect that those shares were cancelled by resolution of the Board. It was not, said his Lordship, at all extraordinary that the plaintiff should have felt himself aggrieved, or that he should have brought this action, and when the matter came to be discussed counsel for defendants did not oppose that part of the application for an injunction. Then, on the 29th of April, in pursuance of that minute, Watt and Howell treated the plaintiff as no longer holding any shares or as being a director. The sole ground for that was the alleged forfeiture; but that was a nullity, and the defendants had no right to prevent the plaintiff from acting as a director, a position which he was entitled to hold. There appeared to be a struggle going on between the plaintiff and Watt and the shareholders who supported them respectively. The disputes were of a nature to be settled by the shareholders themselves, and his Lordship thought that early measures should be taken to bring the matter before them. Meanwhile, he had to determine the legal position of the parties. It appeared from the Directors' report that Mr. Watt and Mr. Brown retired by rotation, and on the 2nd of March, 1888, the following minute appeared in the minute book:—"Mr. John Brown intimated that, owing to the state of his health, he felt compelled reluctantly to resign his seat at the Board, and the Secretary was instructed to write a letter of condolence to Mr. Brown, and to intimate the sincere regret of his late colleagues at the step which he felt compelled to take." It was contended that that was a record of what took place at the meeting. Now, the articles provided that a director intending to resign should tender a written resignation at a Board meeting, and on the acceptance of his resignation his office should be vacant. It was quite plain that Brown did not tender any written resignation at a Board meeting, and that no resignation was accepted. His Lordship was not sure that the minute was a *bona fide* record of what took place. There were suspicions in his mind which which had not been removed by what had been told him by the Secretary of the Company in the box. The next meeting purported to appoint Mr. Howell a director of the Company. On the 16th of March, 1888, this minute appeared in the book:—"Present, Hugh Watt and George Howell.—A letter was read from Mr. L. Swaby intimating his inability, owing to serious indisposition, to be present, but stating that he was agreeable that Mr. Howell, M.P., should be a director of the Company. The Chairman then proposed Mr. Howell's election, and requested that gentleman to attend. Mr. Howell attended, and, having been informed by the Chairman that he had been appointed a director of the Company, returned thanks for his appointment, and took his seat at the Board." It was perfectly plain that there was no appointment. One man could not constitute a meeting, and the articles put it beyond doubt, because they required two Directors to be present before any business could be transacted. His Lordship then referred to further minutes of meetings, remarking that they were irregularly entered, and came to the conclusion that Mr. Howell had never been properly elected a director of the Company at all. He then referred to the proceedings at a meeting convened by a circular issued by the Chairman, and remarked that there was nothing in the articles authorising the Chairman to call meetings. His Lordship then read what purported to be the minute of a meeting held on the 11th of May, 1888, at which the Chairman expressed his opinion that Mr. Swaby was not entitled to be a director of the Company, and the minute further stated that the Directors approved a notice sent to Mr. Swaby in terms of the Board's resolution contained in the minutes of the 6th of April. So, said his Lordship, they purported to exclude the plaintiff altogether from acting as a director. That was one of the most surprising minutes his lordship had ever heard of. Could he believe it, after the melancholy exhibition which he had seen in the witness box? It was a mere story got up by Watt in order to protect his position, and to justify his high-handed proceedings with reference to the forfeiture of the plaintiff's shares. Taking that view, his lordship thought Howell had not been duly elected, and the plaintiff was entitled to an injunction in the terms of his notice of motion.

COMPANIES' MEETINGS.

UNITED TELEPHONE COMPANY.

The eighth annual general meeting of the United Telephone Company, Limited, was held at Cannon-street Hotel, E.C., on Tuesday, **Mr. James Brand** (the Chairman of the Company) presiding.

The **Secretary** (Mr. Thomas Blaikie) having read the notice convening the meeting,

The **Chairman** said: Gentlemen, you have all received a copy of the report, and have, no doubt, studied the accounts. I will not trouble you with going over these accounts just now, as I know that there is a gentleman, a friend of mine, in the room, who is going to make some inquiries as to the accounts by-and-by, and then I will endeavour by myself, or by some of my friends here, to answer him as well as I possibly can. After referring to the action in Parliament, he continued, I should say a word or two on a very important subject indeed, and that is as to our relations with our subsidiary companies. I was very much surprised to read in the report of the South of England Company, held on June 29, some remarks reported to have been made by the chairman of that company as to the relations of his company with the United Company. In reply to Mr. Billett, the chairman said this: Mr. Billett asked, "Has there not been some suggestion for these outlying lines to be connected with London?" And the chairman is reported to have said, "We are not an independent company so far as that is concerned—one-half will have to be run in the United Company's district. We have urged this matter on them repeatedly, but we get no further. With regard to Brighton, it is a joint line between the United Company and ourselves. Under the old arrangement we pay one-half, and derive no immediate advantage from it. It was an experimental line." Well, now, I feel sure that Mr. Bateson, the chairman of the South of England Company, would not willingly say anything but that which he believed to be true, and I can only suppose that he has forgotten the numerous interviews that we have had with him, and the proposals that we (the United Company) have made from time to time. Let me

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tell you the fact as it stands. The United Company have, through the General Post Office, run a wire to Tilbury, among other places, at their own expense. On April 20, 1887, we wrote to the South of England Company offering to work this line at our own expense, and give the South of England Company half of any profit that was made, and to bear the whole loss, if any, ourselves; and I pledged myself to Mr. Bateson that if at the end of one year this manner of working this trunk proved unsatisfactory to him or his company, the whole matter should be revised and settled in a way that should be satisfactory to his company. Now, again, as to the Brighton wire. The General Post Office ran this wire also for the United Telephone Company. For two years, 1884 and 1885, we paid £446. 10s. per annum ourselves, rent to the Post Office. After that I arranged with the Chairman of the South of England Company that his company should pay one-half of the rent of the Brighton wire for 1886, and for all time after; but that the United Company would at their own cost fit up the necessary apparatus in the switch-room at Brighton Since then the South of England Company have worked the Brighton trunk wire without let or hindrance from the United Company. The United Company have paid the rent of the wire for 1887 and 1888 to the General Post Office; but we have not yet received any payment on account of these two years from the South of England Company. On June 29, the South of England Company wrote, agreeing in a great measure to certain proposals I had made in the letter I have mentioned on April 20, 1887, and yet at the meeting that was held on Friday ast—that is, the same day as that on which the letter was written—the Chairman of the South of England Company is reported to have said, in reply to Mr. Billett's question (who said: "Surely it could be no intention of the United to stifle its own children"), "We have proposed terms, and cannot get them"—that is, the United Company—"to second them at all. They refuse to enter on the subject at all. Since I have been in the chair, I have constantly urged this matter on the United Company, but have got no further to-day." Now, such statements as these, of course, are calculated to do great injury to the United Telephone Company in the eyes of you gentlemen, the shareholders, and of the public in general, and I think it is my duty, therefore, to contradict them, and to dwell at some length on this subject. A good deal of the property of the United Company, as you know, consists in its shares in the subsidiary companies, and we should be fools, indeed, if we tried to stifle our own children. It is not true that the United Company puts obstacles in the way of trunk wires. It is our own interest to push trunk wires with all our might. The National Company is as anxious in this direction as we are to join its different centres on to our system. On January 3 this year the United and the National Companies made arrangements mutually satisfactory for the erection and working of a trunk wire to Birmingham. I think I may say that the difficulties of the wayleaves are practically overcome. We have been met in a liberal spirit by the landowners with whose property we interfere, and we hope that within a month we may be able to commence the construction of the line. This line will provide nearly half the distance required to connect Manchester and Liverpool with London, and also enable Nottingham, Leicester, Derby, Sheffield, and other Midland towns to speak to London, as also the Northern district towns of Newcastle, Sunderland, &c. The same desire for inter-communication exists between the Western Counties Company and ourselves, and friendly negotiations are in progress for connecting London and Bristol, and the Western Counties have got as far as Bath. They have considered it best, however, before tackling with us the heavy outlay for the trunk wire to London, to connect their headquarters at Bristol with Newport, Cardiff, Swansea, &c., and the coal and iron fields of South Wales. You are aware that our agreements with our subsidiary companies prevent us running trunk lines from London to any town beyond 12 miles, and working without the consent of the subsidiary companies. They all know, however, that we are willing to join hands with them. I think I have said enough on this matter to show you how groundless are the curious statements that are constantly being made—[A shareholder: No; certainly not.]—that are constantly being made as to the dog-in the-manger policy of the United Company. It is hardly possible for the shareholders to realise the difficulties that we meet with and have to overcome; and I wish the shareholders would lend us their aid to a greater extent than they do. It is surprising how few of the shareholders are subscribers to our lines. I do not think that 10 per cent. of our shareholders subscribe to our exchanges. However, we do the best we can, and during this year we have increased our mileage of wire from 7,500 to 8,700 miles. There are at present free call-rooms for the use of subscribers existing at Oxford-court, Chancery-lane, the Law Courts, the House of Commons, Regent-street, and Edgware-road, and arrangements have been made, in deference to the wishes expressed by some of the shareholders and as a matter of experiment, for establishing paying call-rooms at Kilburn, Balham, Limehouse, Earl's-court, Denmark-hill, Holloway, Brixton, Greenwich, Notting-hill, Croydon, Richmond, and Brentford. I must tell you that these paying call rooms have not been so much pushed by the United Telephone Company as, perhaps, by some of the other companies further north and west. Our opinion is that these call-rooms in London, as a matter of revenue, will not be very successful. In the North they have proved a good source of revenue, but then that is because of the trunk lines existing between town and town, and the public who are not subscribers take advantage of the call-rooms to communicate from town to town, and are willing to pay 3d., or 6d., or 1s., or whatever it is—I don't know exactly. As far as I know, the call-rooms established in the towns have not been made much use of for local communication. However, we think it is a good thing to try the experiment, and if it does not pay us directly by revenue we think it will pay us by educating the people more and more in the inestimable blessings of the telephone. Well, then we have put up during the year new iron derricks, at great expense, of course, to replace those derricks that were destroyed in the snowstorm. We have got one at Oxford-court, another at Queen Victoria-street, Mincing-lane, East India-avenue, Cornhill, the Hop Exchange, and Smithfield, and there is one in preparation for Heddon-street. We have opened a new exchange at Smithfield with a largely-increased capacity, and the lines have been transferred from the old exchange to the new. With the view of centralising the work of switching, three minor exchanges have been closed. These are Leadenhall-street, Stratford, and Shadwell. The exchanges having been transferred to the larger exchanges, a new multiple switch-board has been erected in the new exchange at Smithfield, and preparations are well advanced for erecting multiple switch-boards at East India-avenue, Westminster, and Chancery-lane. We have opened, and got in very good order now, a new trunk line to Croydon on our own poles, free from the induction of railway poles and other electrical wires, and it is working very well. It has only been opened about a month, and we hope it will be a source of good profit to us. Some remarks were then made on the proposed amalgamation scheme, when the Chairman said: I know very well that this matter should be settled promptly, for until it is settled it retards the development of the Company's business in new lines and connections in the direction of which I have already spoken. You will have seen from the accounts laid before you that during last year we have expended nearly £29,000 on this account, but this has been solely within the metropolitan area. The development of the system of trunks will, of course, involve a large expenditure of capital, and one considerably larger than we can provide, as we have hitherto done, out of the sums debited to revenue for depreciation and other things. If and when it is necessary to raise money for this purpose, we will, of course, call you together and ask your advice on the subject. Well, then, as to law during the year, Mr. Winterbottom has sent me this report, which I will read to you. He says: "Since the decision of the Court of Appeal in favour of the Edison patent, in the action against Messrs. Bassano and Slater, of Derby, there has been no serious attack upon the Company's patents, and the Directors were in hopes that the many ingenious attemps to get outside the patents were at an end. However, at the beginning of the present year Mr. Campbell Swinton, a Scotch gentleman, brought out an instrument, and formed a small company to manufacture and sell it, and as the company was beginning to do business on a somewhat extensive scale, it became necessary to take action. The Directors are glad to say that an *interim* injunction was promptly obtained, which has, for the present, put an end to further sales, but the defendants appear inclined to fight the whole question over again. As the question of the validity of the Company's patents has already been decided by the Court of Appeal, and the Directors had the best possible advice (that of the present Attorney-General and other well-known counsel) that the instruments are infringements, they are in no way anxious about the result. At the same time, it is much to be regretted that the law allows limited companies without any uncalled capital to put a patentee to all this expense after the question has already been litigated and decided. Well now, I think I have said enough for the present; but before I move the first resolution—that the report and accounts be taken as read—I shall be glad if any gentlemen have any questions to ask, that they ask them now. I was waiting to see if any questions were going to be asked about the accounts; but in order to have this brought about I have to move: "That the report and accounts be received and adopted, and that a dividend for the half-year ending the 30th April last of 10s. per fully-paid share, and of 5s. on the new shares, less income-tax, be paid—making a total dividend for the year of 15 per cent. on the paid-up capital of the Company."

Mr. James Staats Forbes seconded the motion.

Mr. Sichel offered apologies for opening the discussion, and said he would only start the hare and leave gentlemen on the other side of the table to hunt it. He would begin with the £15,000 for snow expenses last year, which seemed to double the amount which the Chairman at the meeting last year stated was the probable cost of the loss involved—the bill had pretty well doubled itself. He supposed there was some good reason why this was done, but the £15,000 charged this half-year was equal to 3 per cent. on the capital of the Company, and if that had not appeared in the accounts, they would have had a bigger reserve, or they might have been favoured with a bigger cheque for dividends. The Chairman had remarked that he was anxious that the public at large should value the benefit of the services of the Company, and have some understanding of the value of it. With full diffidence, he ventured to think that the public were fully alive to the value of the telephone, and that the place where there was a want of sufficient knowlegde of the value of the telephone was on the other side of the table. He was told that the call offices of the metropolitan area were a loss of revenue, as they led to a loss in regular subscribers; but, as an individual member of the public, and as one coming in contact with a great many who used the telephone, he thought an enormous increase of call offices would be a boon, and ought to be a source of great increase of revenue to the Company; and he would couple with that idea the system of issuing yearly tickets to subscribers at a price of four or five guineas per annum, entitling the holders to employ any call office within the area of the metropolitan district when they wished. If the Board would employ canvassers to increase their subscribers they would find that scarcely a large retail shop in London would not find it a necessity, almost, to take up the idea. Members of clubs would find the system the greatest convenience, and he believed at the Stock Exchange they would find 1,000 or 1,500 members would like to have their residences in connection with the centre of their city occupation. They ought to get 10,000 subscribers who would be pleased to have a telephone ticket in their pockets. He did not claim originality of the idea, for he had seen it employed in Paris. He hoped the Board would entertain it, and that they would appoint a gentleman solely in carrying it out, and pay him in proportion to the new business he brought to the Company He was satisfied that the business was capable of immense extension. Any gentleman who had been in the States knew there was not a two-penny-halfpenny druggist, or grocer, or keeper of dry-goods stores

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who did not constantly use the telephone. In New York, which was only two thirds the size of London, the number of calls was five times as much as in London, but what the American found a necessity was not within the reach of Englishmen, and Englishmen were so stolid and stupid that they did not see the advantages. It was entirely by being restricted that the Company had not the business that it ought to have. It was particularly necessary that they should increase the number of their subscribers in view of the death of their patents three years hence. At the end of that time it would be the connection that would be valuable, and they should be in a better position having regard to the ultimate fate of the Company in being bought up by the Post Office.

Mr. Begg said his friend the Chairman had made an allusion to him in his opening remarks, and he wished to ask some questions. In order to make his criticisms definite, he had written the questions down, and the Chairman knew what questions he proposed to ask. He suggested that the Chairman now answer those questions, and he could follow with any criticisms he might wish.

The **Chairman** said Mr. Begg's first question related to the reserve account—how was it made up? Well, it was made up partly of sums written directly off profit for the year; partly in sums put into account for depreciation; partly in profits derived by the sale of instruments to the Admiralty or to certain railways; and partly from the premiums obtained on the issue of new shares.

Mr. Begg: How is it invested?

The **Chairman:** It is in the air; it is in the poles, the derricks, the wires, and generally in our business.

A Shareholder: So that it is really a surplus capital account?

The **Chairman:** Yes; whichever way it is stated, practically it is the same to the shareholders. Mr. Begg next asked as to Directors' fees, "Are any special fees or allowances drawn by any of the Directors beyond those shown in the accounts?" Well, the only special fee that was drawn by any Director was that by the Managing Director, who did not share in the fees of the other directors, but was paid under a separate arrangement, which was that they paid him £1,000 per annum, and 2½ per cent. on the divisible profit, after 10 per cent. had been paid to the shareholders; in addition, he was paid about £400 for travelling expenses and expenses in London. This year the amount paid him altogether had been about £3,000.

Sir Julian Goldsmid: It is an illegal payment.

Mr. Forbes said it was in accordance with the articles. He read a clause to the effect that the Directors had power to appoint a Managing Director from among their number, on such terms as they might decide.

Mr. Sichel: Does the amount paid to the Directors and the Managing Director come to £15,000 a year?

The **Chairman:** It is nearly £10,000. The Chairman continued: Mr. Begg said the royalties did not appear to have been accurately adjusted, and he asked were any of the companies in arrear, or were accounts in dispute, like that of the South of England Company. As he understood it, there was no discrepancy—it was the way of putting down the royalties. As regarded the other matter, there were sums remaining to be paid by the affiliated companies, and these appeared in the balance-sheet among sundry debtors. In one case a considerable amount was involved, but inasmuch as it was precisely similar to a case concerning the Lancashire and Cheshire Company, which was decided in their favour by the Courts, he did not anticipate any difficulty in settling the matter with other companies on the same basis. Mr. Begg next referred to the charges and working of the metropolitan area, and said they showed large increases for salaries, wages, &c. —say, £7,000—while rentals increased (cash) £2,431, or per rent roll, £6,851 only. Result—less net revenue by £3,302 in cash this year. Why, he asked, was there such an increase? He (the Chairman) had referred this question to Mr. Welton, whose explanation was that these charges were not merely for the expenses of collection of dividends and royalties, and he considered them very moderate indeed. The accounts were made up on the basis that the two revenue accounts belonged to two separate companies. The working charges were made to look worse this year because they compared with the year 1886. Last year the working expenses were less than usual, because during a good part of the time they were rebuilding and maintaining, and in the rebuilding, of course, the maintaining was included, and put into the expenses of the good old snowstorm. They were rebuilding, not maintaining, so the revenue paid for it. Some of the expenses also arose from opening outlying centres. With regard to capital expenditure, Mr. Begg said, "This seems to bring a much reduced increase of revenue—why?" He asked Mr. Welton to explain this.

Mr. Welton said he had in his hand a paper which showed the extent of the fresh exchange lines was 749 new exchange lines, costing £12,760, but the number cancelled was 422, the loss of revenue on that being £9,647, so that the net benefit was £4,113. In the same way they provided 287 fresh exchanges, costing £5,712; but the number cancelled was 138, the rental on which would be £2,975, the net benefit being £2,737 in the year, and the total increase on revenue being £6,851. That would be due to many customers having withdrawn or become bankrupt.

Mr. Begg said he would offer a few remarks. Mr. Brand had paid him a compliment to which he did not think he was entitled. He held that the management of the Company on the one hand was extravagant, and in the second place inefficient. With regard to extravagance, the reserve fund, Mr. Brand explained, consisted principally of two items: there were in it the premiums on the new capital which the Company issued and other sums carried to it for depreciation. He only found the record of one such sum, and that was in 1884; since then the reserve account had been added to without any particulars being given. In 1884 the item placed to reserve was called reserve against depreciation. Depreciation meant waste, and he said that any sum which was depreciation being carried to the account called reserve was misleading. It was a very good thing to have a reserve against a rainy day—or, perhaps, in their case he ought to say against a snowy morning—but the reserve ought to be consolidated and substantial. Then as to premiums on new shares, that was a fair subject for the reserve fund in a sense, but it was a capital reserve, not revenue. They never saw it classed as revenue. But it was not a proper financial entry; it was not a reserve fund that could be used for the ordinary purposes of a reserve. With regard to the Directors' fees, he would leave them to speak for themselves. He thought if they had no complaints of the management, and were a thoroughly prosperous company, with a growth of revenue, they might be contented that the fees were not too large. He did not think even then they would be thoroughly able to be defended; but a defence might be set up for them. With regard to the royalties, the Chairman said the accounts were adjusted to date; that accounted for something in the figures which struck him as rather peculiar. Speaking from memory, the revenue brought in respect of royalties from the sub-companies during the past year represented an increase of £5,600. The royalty might be taken roundly at 10 per cent., therefore that represented £50,000 additional subscription in the sub-companies; but he found, in looking at the revenue of the sub-companies for last year, the total revenue of the companies, other than this, was £200,000. Therefore these companies must have increased their revenues by £50,000 during the past year. Either they had, or they had not. If they had, so much the worse for this Company, because they had only got an increase of £2,600 in their accounts other than royalties; while if they had not, the sums in respect of royalties had been brought unduly into this year's account. The Directors must settle which was the correct reading of these figures. The question of general charges was a difficult one to go into. They might go into the figures all day and not come to a satisfactory conclusion. It seemed that the snowstorm was made to pay for all. They had, first of all, £15,000 charged last year for the snowstorm, and they were told at the last meeting—and nothing could have been clearer—that the whole thing had been charged in the accounts of the year, that was the end of it; and quite right, too, if it had been. But this year a fresh item of £15,000 more was charged for the snowstorm; and whenever they approached anything in the accounts, they had the whole matter jumbled up with the snowstorm, and it was exceedingly difficult to arrive at any localisation of this extravagance. With regard to general revenue, it had been said that this Company consisted of two companies—the Telephone Exchange and the management of the subsidiary companies. What did the other part of the Company's business consist of? Collecting royalties, distributing dividends and taking actions He did not know that the actions were a mistake, because, of course, they must defend their patents; but he saw no justification of an expenditure of £6,000 or £8,000 in salaries, &c. The new capital recently spent brought in very little. Taking the accounts of four years, they found that whereas in the two last years there was an expenditure of £65,000, which had been debited to capital account, had only produced an increase in revenue of £12,000, and that revenue had not been realised, but was only stated on paper; it had not come into the treasury. Taking the two previous years they found that an expenditure of £57,000 brought in £22,000 of new revenue. The explanation might have been in some measure the snowstorm, but he would point out that the revenue was not actual but estimated. After quoting the comparative statement in the accounts to show that the expenditure of capital in the latter period of the Company's existence was not followed by an increase of revenue that ought to result, Mr. Begg said the explanation was probably that a greater number of lines were given up. But this was the strongest condemnation of a company's management. He knew a good deal of telephones in the provinces, having worked amongst them very hard for the last eight or ten years, and he knew that anything like the giving up of a line was an exceedingly rare thing. The necessity for the constant building of new lines and the throwing away of old lines was probably the secret of this Company's discrepancy, and it was an exceedingly bad tribute to the management of the Company and the odour in which it was with the subscribers. So much for the accounts. Now, with regard to the general management of the Company, he would like to say a word or two on this subject. It seemed to him that several points required attention. The Directors some months ago issued a circular, in which they invited suggestions as to the management, and in what respect it could be improved. He took the liberty of replying at some length. The first point he took was the question of the call offices referred to by another speaker. Now, the Directors of this Company seemed to be entirely ignorant of what was going on round about them. Throughout the provinces these call offices had been in existence many years, and he was satisfied that they had been, and were now, a large advantage to the companies using them, and were successful. Three years since they had call offices in Edinburgh, and he knew that they were a constantly-growing source of advantage. The call offices he meant were for the use of the public, not merely for subscribers, as in the case of this Company, and they had them in Manchester, Liverpool, Glasgow, Edinburgh, &c., and one could step in here and there, pay his 6d. or 3d.—whatever it might be—and have his conversation. They were used for local needs, and not, as the Chairman said, for trunk wires. He was glad to find that call offices were now being established by this Company, and hoped they would go on with them. Then there was a question of continuous service. He laid it down as a general proposition that there was not a telephonic exchange that was not open from one year's end to the other continuously, except London, and London was the place of places where such a service was required on Sundays; and for two reasons: in the first place, there was no delivery of letters on that day, and they could scarcely send a telegram on Sunday. The cost of making the system continuous would be practically nothing—not more than £500 or £1,000 a year to establish it at once. The only other question he would trouble them with was the question of trunk wires. They had trunk lines everywhere but in London. Every town of magnitude had

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telephonic communication except London, and here in London there was not a single trunk wire line, except Brighton, which was purely experimental.

The **Chairman**: Oh, no.

Mr. Begg: How many calls do you get?

The **Chairman**: There are a good many calls; it is not our fault if calls are not made. We cannot make the people call.

Mr. Begg remarked that the Chairman said he was willing to join hands with the sub-companies about the trunk scheme; but willing to join hands was not the attitude of the Board of a telephone company. The Board should insist, and if others would not go ahead in the matter compel them to. They could not get a communication of any sort except in Tilbury—and some of them wished they had not got that—and Brighton. He would impress on the Board the absolute necessity of something being done in the matter at once. The greatest bulwark of this Company was its patents, which were three years within their expiration, and unless they made good use of the short remaining time they would not get from the Government, which, no doubt, must ultimately buy the property, anything like what they ought to get. He did not wish to make a hostile motion, but should like to test the feeling of the meeting, and would formally move that the accounts be not passed, and that a committee be appointed to investigate the affairs of the Company and report to the shareholders.

Sir Julian Goldsmid said at the last meeting he made complaints which the Chairman said would be considered. They had been considered by being ignored. He pointed out last year that there was no company with a capital of half a million whose directors were paid excessive sums. He accused the Chairman of concealing the fact at the last meeting that the Managing Director was paid a large sum over and above the Directors' fees.

The **Chairman** denied this, and said he stated definitely how the matter stood.

Sir Julian Goldsmid further stated that after the last meeting one of the Directors, Mr. Quilter, said he quite agreed with him that the Directors were paid too much. He urged that although the fees were provided for in the articles, the articles could be altered. Of the profits made by the Company, the Directors had had a third. It was a a disagreeable thing to make an attack on men of high standing; but he felt that in a company of the sort they had no example of directors being so extravagantly paid. He thought, therefore, that the articles should be altered so that there should be some revision of the accounts. He seconded Mr. Begg's amendment.

Sir Edwin Galsworthy was surprised at the accusation of the last speaker, that the Board kept back the fact that the Managing Director was paid a large sum for his services. That was an unfair charge. He held that the charges of extravagance and inefficiency had not been proved, and as to the Directors' fees, he urged that if they wanted to alter them, let them go the right way to work, and alter the articles of association.

After some further discussion,

The **Chairman** said he would ask his friend, Mr. Forbes, to answer some of the questions asked. He commented on the unexpected violence of the attack on the Directors, when he believed they were giving the shareholders a good account and declaring a good dividend. With regard to the fees, the Directors felt they had made a bargain with the shareholders, and they did not see that under the circumstances of the case they should be called upon to give up the profits of the bargain. It was made some years ago when the invention was first bought, and the Directors had spent a good deal of time and money in developing the thing, which was then utterly unknown in this country. The Directors had kept to the bargain; they had not sought to increase their remuneration, though in some ways he thought they might have done so, and they certainly did not expect it broken on the other side. If the amalgamation took place, there would be new articles of association, and the shareholders could reconsider the question then if they chose. The Chairman then proceeded to read from the transcript of shorthand notes of the last meeting, and showed that the question of the Managing Director's salary was raised by the late Mr. William Abbott and explained by the Chairman.

Sir Julian Goldsmid said he left the meeting before Mr. Abbott spoke.

Sir E. Galsworthy: That does not justify the shareholder in imputing concealment to the Board.

The **Chairman**: I hope Sir Julian Goldsmid will withdraw such an imputation.

Sir J. Goldsmid: Sir Edwin Galsworthy seems to have amused himself by finding out a mare's nest. I did not hear the inference to the matter at the last meeting.

Sir E. Galsworthy: That is not a justification for the charge. I do not know about mare's nests, but I think it would only be an act of decency now to withdraw the charge. The Board deserve our protection.

Sir J. Goldsmid: The Managing Director's salary ought be shown in the accounts. I dont' want to make any charge.

The **Chairman**: But you did do it thoroughly. As to putting it in the accounts, there would be no objection; but surely there was no reason for making such observations as you did. The Chairman then turned to other points raised, and with regard to the snowstorm, the loss was estimated at £15,000, and £5,000 were put aside, which they had expended to within £160. Then, the meaning of the further £15,000 was this: while they were mending their wires they avoided as much as possible calling on subscribers to pay their subscriptions, which, as a rule, were paid beforehand. When they got their system in order they began to collect the money, when they found their large customers demanded a reduction for the three months' delay in the system, and the Directors had to make the best arrangement they could, and allowed about one and a half or two months' subscriptions to people instead of giving them back any money; they gave a 14 months' receipt for 12 months' use.

Mr. Forbes said he was sorry Sir Julian Goldsmid had left the room, because he was the parent of what must be treated as the personal part of the discussion. He was a lawyer, a member of Parliament, a director of a powerful company, and a man of great position, and he would acquit him of any intention of malice aforethought, to cast imputations or make misstatements. He was sorry a man in his position should hazard the statements and imputations that he had done. The contract with the Directors was a legal and binding and moral contract, which they were bound to carry out. £1,500 a year was divided between seven gentlemen. Now, he would undertake to say that in one or two crises in the history of their Company one single hour's work would have justified their Chairman and himself in taking a good many £1,500, and they would find that out in future, too. Why were they taking these large fees? Because, first of all, they had gone into the swim with the shareholders and held a very large number of shares, and therefore they had their shares, and they found the brains and knowledge with which to carry on the business, and had the responsibility of working the Company's money to their advantage. Had they worked it to their advantage? Well, they got £1,500 a-year up to the time when the shareholders received 10 per cent. The averages were the things to look at. They got for five years, during all the labour, anxiety, and discouragement and difficulty of making this Company—because they made it—£210 a-year apiece on the average. He would ask which of them, having the capacity and knowledge, would do this sort of work for £200 a-year? By dint of their brains and knowledge they had got the shareholders' dividend up beyond the 10 per cent., and had become partners; they were to have 20 per cent. for all the money they made after payment of 10 per cent. He would defend that bargain against all the world. The Directors accepted the responsibility and labour of the business on that bargain, which, he said, was a reasonable bargain, and redounded enormously to the interest of the Company. Surely men of business and men of honour were not going, because one party to the bargain had reaped the benefit of it, to begrudge them the result! He would not hold such an opinion of men of business and men of honour. Surely the shareholders had received more than 10 per cent. It was the Directors' moral and legal claim to be participators in the further profits; and what had they got? For three years £750 each. Was that undue remuneration under such circumstances for such men? If they thought it was, let them find other men who would have done for them what the Directors had done in the past, and were capable of doing in the future. Amalgamation had been referred to; but not five men in the room knew what dangers surrounded the Company. They had got three years for the patent to run; after that the whole world might be then competitors, including the Post Office. Were the shareholders going to discourage the Board in their efforts to provide for that period? They had made a substantial property. The £5 share was worth £15; they had a 15 per cent. dividend, and a reserve fund of over £100,000. That was not a bad outcrop of a company which had been eight years in existence He said these things that Sir Julian Goldsmid and the critics might think about them. Mr. Begg's criticisms would have been admirably apposite if he had known anything about the business. Mr. Begg had remarked on the manner in which the Directors had neglected the Company's interests in not developing call offices. If Mr. Begg had the figures before him that he had got, and the knowledge he possessed, he would not have been so very much surprised. He would say, "What is the cream of this business?" And as long as he could skim cream he did not want to skim milk. The cream of this business was the exchange. The exchange returns were the largest income of these companies, in the relation of all to nothing, and these call businesses were a mere *bagatelle*. He found the Lancashire and Cheshire exchange line had a gross income of £81,000, and the trunk wire and call department was £6,500. In the National the gross income was £90.000, and their fees for messages were £1,800. This company, with 8,700 miles of wires, 4,835 exchange subscribers, and 21 exchanges through which the whole of this enormous number of calls had to be forced, was to render the service—not yet nearly as efficient as it ought to be and might be made to be—useless by letting Dick, Tom, and Harry go to the call office, and take possession of wires which were already flooded with their subscribers! That was really the position, but if Mr. Begg had any greater responsibility than talking about it he would not say what he had. The Company had got to force all their works through 21 exchanges—exchanges the difficulty of which was not equalled by any city in the world. They were very differently situated to the cases Mr. Begg had quoted, and they should compare like things with like. There was no comparison of any city or place in the world with London. Look at the mere question of way-leaves! Everything this Company had to do was on sufferance. Their services were multiplied, because they could not get the shortest cuts. Let every man of brains, of knowledge, of temper, and inquiry go into the thing, and see what was to be done in this concern! He hoped Mr. Begg was not going to press for a committee to enquire into their business. He, for one, was not going to submit to any such committee. Either the Directors knew their business and were worthy of confidence or they were not. When the shareholders thought they were not, let them turn them out and let in Mr. Begg, or anyone else they liked. He knew of no form of censure so unjust and so insidious at this committee of inquiry. In order that the shareholders might know that the Directors were not greedy nor negligent of any promises they had made, he would say they had considered the "enormous" payment of the "dreadful" Directors. He, for one, was not going to work for £200 a year; he would carry his brains to a more successful market. The Directors knew the defects of their system; they new its difficulties. The shareholders knew its defects, but did not know its difficulties—that was the difference, and anyone put in to supersede them would very soon find out the difficulties, and would have to acquire it at the shareholders' cost, and slowly—what the Board had acquired after long years, and which was a possession that nothing but long service could give. He therefore asked the share-

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holders to consider whether it was worth while to join with Mr. Begg and upset the present Board. Let them recollect for a moment that they were a Company which had excited jealousy all round by the large dividend they had paid, and also that they would be face to face with wholesale competition in three years, and with a Government who would probably use their powers to obtain this property. The future would require all the brains and knowledge that the Company had got in their present Directors, and it would be no favour to have paid them their fees if, as the result of their exertions, they succeeded in carrying the Company on up to the time when it was taken over by the Government.

Mr. Begg said Mr. Forbes had made a statement to the effect that he was ignorant of the subject. ("No, no.") He would ask his friend, Mr. Brand, to state whether he did not know he had been ten years actively engaged on telephone work. He might say, as the point had been raised, that he knew down to the minutest detail all the inner working of every item.

The Chairman said he told his colleagues that Mr. Begg was a fair criticiser, and had a good d al of experience. Mr. Forbes did not mean he was ignorant of telephone work, but of the many difficulties the Company had to combat, and he said so too

After some further debate Mr. Begg offered to withdraw his amendment, but the Chairman put it to the meeting, when it received but a small amount of support.

The original motion was then agreed to.

Mr. John W. Batten and Mr. Frederick R. Leyland, the retiring Directors, were re-elected, as were also the Auditors.

Sir E Galsworthy proposed a vote of thanks to the Chairman.

Mr. Begg seconded the motion, which was carried, and the proceedings then closed.

SOUTH OF ENGLAND TELEPHONE COMPANY, LIMITED.

The fifth ordinary general meeting of this Company was held on Friday at Winchester House, Old Broad-street.

Mr. D. Owen Bateson, who presided, stated that their exchange lines had increased from 1,130 in 1887, to 1,521 in 1888, and the private lines from 348 to 386. In the latter item the new lines had been many more than were indicated by the figures, but there had been an unusual number of withdrawals, occasioned, he supposed, by some of their subscribers having been induced by apparent cheapness to try some other instruments. He did not think there would be a continuance of the withdrawals, and some of their former subscribers had returned to them. Their gross rentals stood at £19,325, being an increase over those of 1887 of £4,135. The management and working expenses had been £5,099, or £901 more. Some of the extra expenditure was due to charges for strengthening their system where they had found it necessary. The whole of the 20,000 preference shares of £5 were now issued. It would be necessary before long to call another 10s., but the Board would delay making the call as long as possible, knowing that the 6 per cent. interest would be an additional charge on the Company. Their next trunk lines would be between Canterbury and Ramsgate, Deal, and Ashford. Their line between Margate and Westgate they had been obliged to abandon owing to the obstructive policy of the representative of a charitable institution, but that was quite an exceptional case. The exchange in Canterbury promised well, and they were making that a centre from which various lines were to radiate—namely, to Dover and Folkestone, in the first place, and that portion of the scheme was nearly complete. Subsequently, lines to Ramsgate and Margate would be run; also to Deal, Sandwich, Ashford, and probably Faversham. If they carried out that plan, each place on the radius would be able to speak to subscribers at all the other towns on the radius. In many of their districts they had established fee-call offices, worked by automatic call-boxes, by means of which anyone, whether a subscriber or not, on payment of 3d. for local or 6d. for trunk communication, could call up subscribers on the exchange, and have three minutes' conversation. They had paid two half-yearly dividends on the preference shares, leaving them with £3,115. They had placed £500 to reserve—a fund which would enable them to meet any disaster without jeopardising their dividend; and they proposed to pay a dividend of ½ per cent., carrying forward £1,115. He concluded by moving the adoption of the report.

Mr. Alexander MacGregor seconded the motion.

In answer to questions, the **Chairman** stated that they could run their lines to the 12-mile radius, but they could do no work in the district of the United Company without the consent of that Company. They had repeatedly endeavoured to urge the matter on the attention of the United Company, who, however, simply declined to discuss the subject with them. With regard to a consolidation of all the telephones, there had been a meeting of the subsidiary companies and of the United Company, and a sub-committee had been formed to investigate on what terms such an arrangement could be carried out.

The motion was adopted, and the dividend recommended was declared, the retiring Director and Auditor being afterwards re-appointed.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY.

A general meeting of the London Platino-Brazilian Telegraph Company, Limited, was held on Thursday week at Winchester House, Old Broad-street, E.C., **Capt. Francis Pavy** in the chair, for electing new directors.

The **Chairman** stated that the agreements between the Company and the Western and Brazilian Telegraph Company had been carried into effect, and out of 38,348 shares forming the Platino capital, 33,515 had been exchanged for Western and Brazilian shares, or 4,000 shares beyond the three-fourths requisite to give effect to the agreements. The agreements had been duly registered and lodged at Somerset House, so that matters were now in order and the exchange virtually completed. In these circumstances, having carried over the agreements, it was only left, according to the arrangements, for the present Directors to resign and for others to be appointed. He concluded by moving a resolution accepting the resignations of Sir John Pender, Captain F. Pavy, and Mr. John Hollocombe, and appointing Lord R. Howe Browne, Major A. Wood, and Messrs. W. S. Andrews, C. W. Earle, D. W. Goodsall, and H. Weaver, Directors of the Company.

Mr. J. Hollocombe seconded the motion, which was carried unanimously.

CITY NOTES.

Removal.—The Schanschieff Electric Light and Power Company, Limited, is removing from 65 to 44, Basinghall-street.

West Coast of America Telegraph Company.—The receipts of the West Coast of America Telegraph Company for June were £6,225.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company for the week ended June 29 amounted to £3,941.

Manitoba.—Messrs. Robert A. McLean and Co. have notified for payment the half-yearly interest on Manitoba Electric and Gas Light Company First Mortgage Debentures.

Direct Spanish Telegraph Company.—The estimated receipts of the Direct Spanish Telegraph Company for June are £1,690, against £1,561 in the corresponding period of last year.

Eastern Telegraph Company.—The Eastern Telegraph Company's traffic receipts for the month of June, 1888, amounted to £48,096, and to £45,426 in the corresponding period of 1887.

Telegraph Construction and Maintenance Company. — The Directors of the Telegraph Construction and Maintenance Company have decided to pay an interim dividend of 12s. per share, on the 17th inst.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The traffic receipts of the Eastern Extension, Australasia, and China Telegraph Company, Limited, for the month of June, 1888, amounted to £41,764, and to £35,138 in the corresponding period of 1887.

West India and Panama Telegraph Company.—The estimated traffic receipts of the West India and Panama Telegraph Company for the half-month ending June 30 are £2,553, as compared with £3,052 in the corresponding period of 1887. The March receipts, estimated at £7,036, realised £7,051.

Cuba Submarine Telegraph Company.—The number of messages passing over the lines of the Cuba Submarine Telegraph Company during June was 4,114, estimated to produce £3,000, against 3,613 messages, producing £2,929, in the corresponding month of last year. The receipts for March, estimated at £3,800, realised £3,835.

United River Plate Telephone Company.—The report of the United River Plate Telephone Company, Limited, showing the result of the operations during the sixteen months ended the 31st of March, states that there is a net profit of £24,166, out of which an interim dividend of 2½ per cent. was paid in October, the actual available balance being thereby reduced to £17,916. The Directors recommend a further dividend of 4½ per cent., being 4s. 6d. per share, tax free, £5,000 being placed to a depreciation and renewal fund, and £1,666 carried forward.

The Buckingham Electric Light and Power Supply Company, Limited.—Registered by Digby and Liddle (agents for Henry Small, solicitor, Buckingham). The capital of the Company is £5,000, in shares of £1 each. Object: To carry on at Buckingham and elsewhere, in the county of Buckingham, the business of an electric light and power supply company in all its branches, and in particular to construct, lay down, erect, establish, fix, and carry out all necessary cables, wires, lines, primary, secondary and other batteries, accumulators, lamps, apparatus and works, and to generate, accumulate, distribute and supply electricity; and to light streets, wharves, markets, churches, chapels, shops, buildings, and places both public and private.

Electrical Purification Association, Limited.—Registered by Hargrove and Co., 3, Victoria-street, Westminster, S.W., with a capital of £15,000, in shares of £1 each. Object: To acquire certain patents Nos. 1,333, 15,760, 15,939, 472, and 1,105. The patents generally relate to improved means of oxidising and decomposing by electrical action organic matter and inorganic salts in sewage water and other liquids, and the production of certain products therefrom, and improvements in the means or appliances for treating sewage by electrolytic action, and for the disposing of the deposits thereof. The first subscribers are:—

	Shares
W. Webster, electrician, Lee Park, S.E.	200
T. Slater, engineer, Westminster	1,000
J. Crow, secretary, 54, Wickham-road, Brockley	1
J. H. Jones, Cairo, Egypt	1
A. Cassaveti, 6, Clarendon-place, Hyde-park	1
W. Porter, Baring-park, High-road, Lee, S.E.	1
E. Webster, 9, Lee-terrace, Lee, S.E.	1

The number of directors shall not be more than four nor less than three. Wm. Webster, Edwin Webster, Thos. Slater, and Alexander Cassavetti shall be the first directors. Until otherwise determined by extraordinary resolution, the directors for the time being shall continue to hold offices subject only to clause 57 of the Companies' Act, 1862 (Table A). Any vacancy in the Board of Directors shall be filled up by the Company in general meeting.

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PROVISIONAL PATENTS, 1888.

JUNE 22.

9141. **A new or improved automatic electrifying apparatus.** Charles Huelser, of the firm of Huelser and Co., 142, Fleet-street, London. (Julius Müller, Germany.)

JUNE 23.

9177. **Improvements in the screws and screw nuts of the stay rods and swivels or stay fasteners of telegraph poles; which improvements are also applicable to the screws and screw nuts of other articles exposed or liable to be exposed to the weather.** Howard Cochrane Jobson, 7, Staple-inn, Middlesex.

9206. **Improvements in galvanic elements or batteries.** Carl Lütcke and Paul George, 166, Fleet-street, London. (Complete specification.)

JUNE 25.

9250. **An improvement form of voltaic cell, the positive element in which consists of an amalgam of mercury with zinc and sodium, or zinc and potassium.** Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London,

9254. **Controlling devices operated by means of the thermic effects of electric currents.** Bernard Mervyn Drake and John Marshall Goram, 2, Princes Mansions, Victoria-street, Westminster, and Edward Manville and William Leonard Madgin, 36, Albert Embankment, London, S.E.

JUNE 26.

9277. **An electric automatic annunciator.** Henry Binko, 34, Leadenhall-street, London.

9303. **Filling lining and non-conducting material.** Henry Ward Johns, 76, Chancery-lane, London, W.C. (Complete specification.)

9308. **Improvements relating to dynamo-electric machines.** Joseph Edmondson, 45, Southampton-buildings, London, W.C.

9332. **Improvements in electrical connection of railroad rails.** Frederick Stitzel and Charles Weinedel, 18, Buckingham-street, Strand, London, Middlesex. (Complete specification.)

9333. **Improvements in and relating to electric arc lamps or lighting apparatus.** Henri Pidot and Henri Pautier, 45, Southampton-buildings, London, W.C.

JUNE 27.

9381. **Improvements in electric batteries.** Alexander Imschenetzky, 6, Bream's-buildings, Chancery-lane, London.

JUNE 28.

9405. **A method to enable alternating currents of electricity to be utilised for charging electrical accumulators.** R Frederick Yorke, Cecil House, Redhill, Surrey.

COMPLETE SPECIFICATIONS ACCEPTED.

JUNE 29, 1887.

9264. **Improvements in electric clocks.** James Grieve Lorrain, Norfolk House, Victoria Embankment, London, W.C.

JULY 29, 1887.

10,555. **Improvements in electrical batteries.** Chaimsonovitz Prosper Elieson, 4, South-street, Finsbury, London.

AUGUST 13, 1857.

11,091. **Improvements in and connected with friction couplings governed by electricity.** John Smith Raworth and Henry Mannington Sayers, 46, Lincoln's-inn-fields, London, W.C.

AUGUST 29, 1887.

11,704. **An improvement in electrical insulators.** William Edwd. Langdon, John Crisp Fuller, and George Fuller, 33, Chancery-lane, London.

11,718. **Improvements in actuating mechanism for electrostatic generators.** Hermann Gläsar, 323, High Holborn, London, W.C.

AUGUST 30, 1887.

11,776. **New or improved system or apparatus for synchronizing electric telegraph instruments.** William Henry Beck, 115, Cannon-street, London, E C. (Gilbert Alfred Cassagnes, France.)

APRIL 19, 1888

5831. **Improvements in means or apparatus for lifting, lowering, and regulating the height of the elements in electric batteries.** Theodor Schönherr-Schöner, 2, East-parade, Leeds, Yorkshire.

APRIL 26, 1888.

6191. **A mode of preparing carbons for electric arc lighting.** Carl Anton Johannes Hugo Schroeder, 17, Althorpe-road, Upper Tooting, London, S.W.

MAY 29, 1888.

7851. **Improvements in switches for electric circuits.** William Phillips Thompson, 6, Lord-street, Liverpool. (George Westinghouse, Junior, United States.)

7853. **Improvements in or relating to storage batteries.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles David Paige Gibson, United States.)

SPECIFICATIONS PUBLISHED.

1887.

7865. **Dynamo-electric, &c., machines.** F. George. 8d.

9191. **Type printing telegraphs.** G. A. Scott. 1s. 6d.

9843. **Compensating electric measuring instruments for temperature.** W. T. Goolden and S. Evershed. 8d.

10,606. **Distributing, storing, &c., electric currents.** L. Gerard. 11d.

10,748. **Portable batteries for electric light.** A. Schanschieff. 8d.

12,645. **Electrical batteries for driving tramway vehicles.** W. D. Sandwelf. 6d.

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6237. **Electric batteries.** A. Millar. 6d.

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6481. **Electrical transmission of power, &c.** H. H. Lake (Tesla.) 8d.

6502. **Generating and distributing electric currents, &c.** H. H. Lake. (Tesla.) 8d.

1881.

2272. **Secondary batteries.** J. W. Swan. 6d.—Fourth edition.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday.
3 Jan.	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	3
12 Feb.	2/0	— fully paid	5	3 3/4
26 April	1%	Anglo-American	100	36 1/2
26 April	2%	— Pref.	100	60 1/2
12 Feb., 85	5/0	— Def.	100	11 3/4
28 June	3/0	Brazilian Submarine	10	12 5/8
14 June	1/0	Con Telephone & Main	1	3/4x
15 Feb.	8/0	Cuba	10	13
28 July	10/0	— 10% Pref.	10	19 1/2
28 Mar.	2/2 1/2	Direct Spanish	9	3 3/4
28 Mar.	5/0	— 10% Pref.	10	9 1/2
28 Mar.	2/0	Direct United States	20	8 5/8
12 April	2/6	Eastern	10	11 5/8
12 April	3/0	— 6% Pref.	10	15
1 Feb.	5%	— 5%, 1899	100	111
26 April	4%	— 4% Deb. Stock	100	108
26 April	5/6	Eastern Extension, Australasia & China	10	12 3/4
1 Feb.	6%	— 6% Deb., 1891	100	106
3 Jan.	5%	— 5% Deb., 1900	100	103 1/2
2 May	5%	— — 1890	100	103
3 Jan.	5%	Eastern & S. African, 1900	100	106
28 Mar.	8/3	German Union	10	6 1/8x
12 April	2/0	Globe Telegraph Trust	10	5 3/4
12 April	3/0	— 6% Pref.	10	13 7/8
30 April	5/0	Great Northern	10	14 1/4
1 Mar.	5%	Gt. Northern 5% Deb., '83.	100	108
29 Feb.	10/0	India Rubber, G. P. & Tel.	10	17 1/2
11 May	37/6	Indo-European	25	38
30 May	3/0	London Platino-Brazilian	10	6 1/4
16 Mar.	5%	Maxim Weston	1	1/8
30 May	2 1/2%	Oriental Telephone	11	3/8
26 April	4/0	Reuter's	8	8
		Swan United	3 1/2	2 3/8
15 Feb.	15 1/2%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
29 Feb.	36/0	Telegraph Construction	12	40
3 Jan.	6/0	— 6%, 1889	100	105
30 Nov.	5/0	United Telephone	5	14
		West African	10	5 1/4
1 Mar.	5%	— 5% Debs.	100	95
29 Dec.	6/0	West Coast of America	10	6 1/2
31 Dec.	8%	— 8% Debs.	100	117
11 May	9/	Western and Brazilian	15	10
11 May	6/10 1/2	— Preferred	7 1/2	6 1/2
11 May	2/1 1/2	— Deferred	7 1/2	4
1 Feb.	6%	— 6% A	100	112
1 Feb.	6%	— 6% B	100	107 1/4
		West India and Panama	10	1
30 May	10/0	— 6% 1st Pref.	10	10 7/8
13 May, '80		— 6% 2nd Pref.	10	7 1/2
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	103

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NOTES.

Copper from Japan.—The output of copper from mines in Japan is greatly increasing under foreign demands.

Technical Education.—It is hardly believed that the Government will proceed with the Technical Bill this Session.

The Cruto Lamp.—A French company has started a factory for manufacturing Cruto lamps in Paris. It is near Breguet's well-known works.

Brussels.—The lighting of the Northern Station at Brussels has been given to the Société Industrielle d'Electricité, the cost being 61,825 francs

Pullman Electric Cars. — Pullman's Palace Car Company are turning out a considerable number of cars fitted with electric motors for street tramway work.

Bingley Hall. — Messrs. Chamberlain and Hookham have received the contract, for the next three years, to light Bingley Hall, which is the largest in Birmingham, and is capable of containing 20,000 people.

Common as Blackberries.—Electric railways, says the *American Engineering and Mining Journal*, are becoming so common that the announcement of a new line or the adoption of electric locomotives scarcely attract attention.

Mill Lighting.—Another mill has been lighted in Bradford. Messrs. Dixon and Farrant, of Marshalls Mill, have had their works lighted by Mr. Wilson Hartnell. The dynamo is a Crompton 20-light machine, and the installation has been carried out in the usual careful and thorough manner that distinguishes Mr. Hartnell's work.

St. Catherine's Lighthouse.—In our issue of May 25 we referred to the installation of the electric light at this lighthouse, and our contemporary *The Engineer* has recently described the arrangement adopted. The lamp is a modified Serrin-Berjot, burning Sir James Douglas's fluted carbons. The three compound engines are by Messrs. Robey and Co., and the two dynamos are by De Meritens, of Paris.

Hospital Fete.—On Thursday in last week a fête, in commemoration of the silver wedding of the Prince and Princess of Wales, was held at the National Hospital for the Paralysed and Epileptic, at which the Princess Louise was present. The wards were prettily decorated with flowers and fairy lamps, and a variety of scientific and electrical apparatus was exhibited—among other things, the writing telegraph.

Newton Abbot.—Messrs. Vicary-Tanners, of Newton Abbot, are using their surplus engine-power for providing the electric light in their mills at Bradley. There are 82 incandescent lamps in the mill. The work has been carried out by Mr. Radcliff, who has also arranged to provide a temporary installation of electric light at the Winter Garden building at Torquay during the exhibition at the beginning of August.

Fire Brigade Alarms.—At Kidderminster it was notified that electric communication having been effected between the Town Hall and the members of the fire brigade, the use of the steam whistle as an alarm will be discontinued. We should be interested to know how many towns there are still in England which have not yet availed themselves of the use of electricity in connection with the fire brigade.

Printing by Electricity.—The San Francisco *Mining Scientific Press* is printed on a machine run by an electric-motor worked off the main of the Pacific Power Company. "This power," says the editor, "leaves nothing to be desired. It is steady, cheap, noiseless, odourless, free from dust, ashes and dirt, reliable, and 'altogether lovely.'" The motor employed is Prof. Keith's (of San Francisco) patent, and works also the passenger elevator for the offices.

Lambeth.—At the Vestry meeting, on July 5, a letter was received from the Assistant-Secretary of the Board of Trade, stating that all reference to the parish of Lambeth had been omitted from the proposed South Metropolitan Electric Lighting Order.—A notice was received from Messrs. Deacon, Gibson, and Medcalf that the London Electric Supply Corporation intended to apply for a provisional order for the supply of electricity for an area which would include the whole of the parish of Lambeth. A similar notice was received from the South Metropolitan Electric Supply Company.

The Microphone in War.—According to the French papers, the microphone was used during the manœuvres of the 17th Army Corps to detect the passage of bodies of troops in the neighbourhood of forts. From the experiments made, it appears that no difficulty was experienced in distinguishing between the various arms which passed the buried microphone, infantry, cavalry, artillery, and engineers all indicating their personality unmistakably. An attempt was made to count the number of men of each arm of the service, and we are told that out of 5,000 men only 340 were unaccounted for.

Continental Telegraphs.—Mr. Henniker Heaton, in the House of Commons last Monday asked the Postmaster-General whether an agreement had been made between France and England for conducting the telegraph service between the two countries independent of any private company, and whether he was prepared to state the nature of the agreement entered into and the rate per word of the cable messages which had been decided on. Mr. Raikes, in reply, stated he was not yet in a position, with a due regard to the public interest, to give any information on this subject. As soon as the negotiations have reached a point admitting of it, he will be glad to inform the House as to the arrangements contemplated.

Electrolytic Bleaching. — Messrs. Paterson and Cooper are busy with a considerable quantity of electrical plant for use in the Hermite process of electrolytic bleaching, used in treating paper pulp. A current of 1,200 amperes is used in the process, at a pressure varying with the number of vats employed. The meter for these large currents is a very peculiar and extremely simple one, illustrated by us a few weeks ago. The "coil" consists of a single solid bar of copper, about 1¼in. in diameter, closely embraced by an iron ring, which acts as magnet under the influence of the large current; the needle oscillates in a slot turned in the ends of this. The details of the process of bleaching are not yet made public, but are said to be very satisfactory.

Henley Regatta.—Quite one of the noticeable features at Henley Regatta this season was the little electric launch sent down by Messrs. Immisch and Co., which flitted about without apparent means of progress, and seemingly according to its own volition. The question of providing power for the launch has been boldly tackled by Messrs. Immisch, who have laid themselves out for providing charging stations at various points along the Thames. One of these stations

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was in evidence at Henley. It consists of a large barge of 50 tons burden, fitted with an engine and a couple of dynamos, which was towed up the river by the electric launch. In the evening the station at Henley Regatta was brilliantly lighted by incandescents, and contributed its quota to the illuminations.

Old Style Lighting Revived.—Electric light contractors had better be looking around. We hear of several towns actually going back to oil for their public lighting. The town authorities of Erith, Kent, so we understand, have adopted a new pneumatic safety oil-lamp in lieu of gas, and a special exhibit of this lamp for public lighting is to be seen at the Glasgow Exhibition. The lamp burns 60 hours, and requires trimming only once a month, and costs 50s. a lamp per annum of 30 c.p.—gas of 14 c.p. costing 80s. There is nothing like competition for stirring up all the latent energies of our rivals, and what with regenerative and incandescent gas-burners and pneumatic oil-lamps they are indeed doing wonders. But we hardly suppose our electric light pioneers are going to be left behind through a little enthusiasm and flare up of the "old style" illuminants.

Quite Unforeseen.—The other day a pair of tom-tits went a long way towards producing a catastrophe, which no amount of foresight could have provided for. The grounds of the powder works at St. Medard, near Bordeaux, are lighted by arc lamps, and one of these has a resistance-box interpolated in the circuit, which is fixed to the lamp-post. This box had two holes in it, and a tom-tit, prospecting for a nesting place, decided in favour of the box, and proceeded to collect therein the usual straws and grasses wherein to rear its brood. Unfortunately, a high current heated the german silver wires forming the resistance coils to such an extent as to fire the nest, and then the box, which fell to the ground. Luckily the ground was damp, and the fire spread no further; but given dry weather and a light breeze, and many another home, besides that of the innocent causes of the fire, might have been destroyed.

London Bridge. — We understand that Mr. F. J. Beaumont and Mr. J. Kent, of the College of Electrical Engineering, Railway-approach, London Bridge, are starting a central station for that locality. The installation will present some novel features, in that the machinery for the central station is in connection with the "College." The pupils, after teaching, will be paid salaries, and employed in actual work, where possible, in installing and running what may be an extending central station. Arrangements are at present made for supplying 24 arc lamps in the various shops in the Railway-approach, and the neighbouring Turkish Bath, together some 100 or so incandescent lamps, and it is anticipated the demand will spread in that busy locality. The arc lamps are on a new design, and are exceedingly simple in construction. Practically, hardly anything is to be seen outside the globe except a small box or cap on the top, and the light given, moreover, is very steady.

Electric Lighting at Westminster.—In the House of Commons, on Monday, Sir H. Roscoe asked the First Commissioner of Works whether, in view of the serious deterioration of the stone fretwork of the interior of the Houses of Parliament, owing to the corrosive action of the products of combustion of gas, he would undertake to extend the system of electric lighting throughout the building, so as to avoid the evil consequences which attended the present system. Mr. Plunkett, in reply, said to extend the present system of electric lighting throughout the whole of both Houses of Parliament would involve a very considerable expenditure, not less than £40,000 for plant. It would, however, probably effect a considerable saving in the annual cost of lighting the palace. Before making any proposals upon the subject it would be necessary to consider whether some more economical way of obtaining the necessary current of electricity than that which we now use may be made available.

Poole.—The Corporation has been requesting tenders for the lighting of the borough from the 16th August to the 24th May, and the quay lamps all the year round. A tender was sent in for this purpose by the Poole Electric Light Company, whose letter stated that the firm of Messrs. Paris and Scott, of Norwich, electricians, had had a representative in the town who had prepared a plan, which was sent, showing the position in the town where the company would undertake to place incandescent lamps of 100 c.p. The cost would be £5 per annum for each 100 c.p. lamp, and £1 each for the smaller lamps, for which the present posts could be used. The Council would have to supply the lamps, which would cost about 25s. or 30s. each, and the company would provide the posts if they were allowed certain rights of erection. The charge would include lighting and extinguishing. The estimated cost for lighting the borough was £500 a year. The whole matter was referred to a committee.

The Brush Patents.—An important decision has been filed in the Federal court at Indianapolis, in the case of Charles F. Brush, of Cleveland, against John Owen and others, in which an infringement of patent was alleged by complainants, testing the validity of what is known as the Jenney system. The opinion, by Judge Gresham, is as follows:—1. The invention shown in the patent sued on was declared in patents 212,183 and 218,208; but in 212,183 the examiner held that Brush's claims were too broad. That decision was acquiesced in, and the invention which was there described, claimed, and rejected is now claimed in the patent sued on. The rejected invention was dedicated to the public by acquiescence in the ruling of the examiner, and cannot be claimed in a subsequent patent against others who meantime entered the field and used the rejected invention. 2. The patent in suit is limited to solenoids, and it does not include the common or electro-magnet, and thus construed the patent sued on is not infringed by the defendants. These, briefly, are the reasons for dismissing the bill for want of equity. The decision is regarded as unusually important, and the case is expected to go to the Supreme Court of the United States.

Fuel Testing Station.—A discussion has been going on in the engineering papers with reference to a proposed fuel testing station for London—a proposal in which it is likely that electrical engineers might be glad to co-operate. It has been mentioned as remarkable that sellers of coal take no trouble to find out the heat-generating power of the fuel that they are selling, nor do manufacturers on their part take much pains to find out what is the most that can theoretically be expected from the coal they buy, nor how far they obtain a good result in practice for their expenditure. A manufacturer ought to know exactly how many gallons of water could be evaporated by a ton of coal, and keep a record of his actual results. Tests of heat-producing qualities of coal would then be the recommendation by which a colliery owner or coal dealer would influence his customers, and

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the users would be able to become acquainted with the latest improvements in the way of heat generators, smoke consumers, and furnace apparatus generally. Similar testing stations have been existent for some time on the Continent, and the proposal of a permanent institution of this kind in the neighbourhood of London seems to us worthy of all support.

Electricity and Fishing.—Prince Albert of Monaco, says the Paris correspondent of the *Daily Telegraph*, is now coming out in the character of a deep sea fisherman, but not for mere pastime. He is trawling in his yacht, the "Hirondelle," along the Atlantic coast, being intent on hauling in rare specimens of the finny tribe in the superior interests of science. A few years ago the distinguished yachtsman was engaged in observing the directions and velocity of the tides, and the results of his useful nautical researches were duly communicated to the Paris Academy of Sciences. The Prince has now informed M. Milne-Edwards of his present experiences, which will doubtless prove of great use to zoologists. A new and improved osier fishing-net has been supplied to the "Hirondelle," and this apparatus is made more efficient by means of an electric lamp, which will act as a bait and a snare to the fish, just as the candle does to the moth. The apparatus has been invented by Dr. Regnard, who has overcome the difficulties connected with supplying the electric lamp from a generator kept on board the yacht by simply storing the current in an iron case surmounted by a globe, and this is kept in its place at any depth, and is capable of resisting the pressure of immense volumes of water by means of an indiarubber air-balloon.

Barnet.—There seems to be some little delay in the arrangement for lighting Barnet, the Board having originally decided on 16-candle lamps, and Mr. Joel having made an agreement with them on that basis; but subsequently it was suggested that 16-candle lamps were not the best form of electric lighting for street purposes, and modifications were put forward. At the last meeting of the Board the following motion was made: "That this Board is willing to adopt 32-c.p. incandescent lamps in place of the 16-candle lamps mentioned in the contract submitted, at a price to be agreed between this Board and Mr. Joel." Six of the members voted for the motion, three against, so that it was carried. We have very carefully read a full report of the discussion upon the subject, and we think the whole arrangement is still in a very unsatisfactory condition, and there is no doubt that the remark of Mr. Tyron is not very far from correct. He asked what proof was there that in a short time they may not be told that 50-candle lamps were better than 32, just as they were now told that the latter were better than 16. The reply to this was that 50 must be better than 32, and 100 would be better still. It is a matter of judgment. Our opinion upon this whole matter is that incandescent lamps are not exactly suited for street lighting. The great argument in favour of the adoption of the electric light, states the report, is that the town is going to save money. This may be an absolute fact, but we doubt if much money is going to be gained by the supply of seventy-one lamps, unless this work for the Local Board proves to be only a peg upon which to hang the much larger work of lighting the houses of Barnet.

The Brush Company's Excursion.—The eighth annual excursion and dinner of the employés of the Anglo-American Brush Electric Light Corporation came off with great *éclat* on Saturday, July 7th. The party, numbering 146, left Liverpool-street (per Great Eastern Railway) about 7 o'clock in the morning, and reached the pretty seaside resort of Clacton-on-Sea at 10:42 a.m. The whole then entered with zest and hilarity into the full enjoyment of the scene, boating and bathing being freely indulged in, and all making the best of their time. At 1 o'clock the party adjourned to the Osborne Hotel, and partook of a splendid spread prepared by the genial host. The viands reflected greatly to the credit of the worthy caterer, and the whole were cleared with electric despatch. When the cloth was removed, the chair was taken by E. Garcke, Esq., secretary of the Corporation, who proposed the first toast, "The Queen and Royal Family." P. Sellon, Esq., gave the toast, "The corporation," and in a very interesting speech dwelt upon the unity which existed between employers and employés. Toast, "The Staff," was given by Mr. J. Evans, who referred to the "bond of unity" which has ever existed between them, and further expressed his belief that these annual gatherings did much to foster a better feeling amongst all classes. Mr. Fells, a member of the honorary staff, very ably and suitably replied in sympathetic terms. G. C. Sillar, Esq., the esteemed works manager, expressed in glowing terms his great pleasure in being present. There were also present Messrs. Mordey, Jackson, and Paterson, members of the hon. staff. Songs were well rendered during the proceedings by Mr. J. Fone, J. Brady, Mr. Ashton, who with much credit sung the "Forge," and their old friend, Mr. Favier, who in good style sung "The Four Jolly Smiths," amid cheers and enthusiastic encores. The party arrived back in London at 10 p.m. all safe and in good order, highly delighted with their seaside trip.

Electric Night Signals for Use at Sea.—The system of signals by incandescent electric lights, as recently adopted in the German and Italian navies, was exhibited by Lieutenant W. H. Beehler, United States Navy, on board the United States steamer "Atlanta," at Annapolis, recently, during the graduating exercises. The electric lamps are used in three lanterns, 12ft. apart, hoisted at the masthead, and the lights are displayed by means of a switch-box to open and close circuit through the combination of lights to make the desired signal. The lamps are arranged in pairs of one red and one white Edison lamp. Each of the three lanterns contains a pair of lamps, and no two lamps in the same lantern are displayed at the same time. The switch-box is a brass cylinder five inches in diameter and two inches high. Its upper surface is a dial with fourteen discs, ¼in. in diameter. These discs are made of pieces of red and white glass arranged to show the same combination of signal lights displayed in the lanterns aloft. It has an index, and the knob in the centre serves as a key, which, when raised, closes the circuit through the lamps aloft, corresponding to the combination covered by the index on the dial. When this knob is depressed, the lights aloft are immediately extinguished. The box has terminals to the dynamo machine, and six wires with a common return wire to the Edison lamps. It also has a receptacle for a small Edison lamp in the box to illuminate the red and white glass discs on the dial to be visible at night. The fourteen combinations possible are as follows: White, 1. Red, 2. White—red, 3. Red—white, 4. White—white, 5. Red—red, 6. White—red—red, 7. Red—white—white, 8. White—white—red, 9. Red—red—white, 0. White—red—white, correct. Red—white

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—red—preparatory. White—white—white—answering. Red—red—red, interrogatory. The system is readily adapted for the general naval signal-book and telegraphic dictionary like the flag numerals of the day signals. In order to make any signal, the message is first sought in the signal-book and the number corresponding thereto is then signalled.

Accumulators for Tramways.—"When this company," writes the president of the Julien Traction Company, "began to make storage batteries in this country some two years ago, it was compelled to adopt the rather crude methods then and now in use in England and on the Continent, and still in use by every other company but this. We refer chiefly to the fact that the battery had to be entirely hand-made; but we have recently invented machinery (fully covered by United States patents), more especially our mechanical filler, whereby two persons, with one machine, can make more battery in a day than 50 persons could hitherto make. This has enabled us to reduce the cost of the battery to at least one-half of what it has hitherto been. It has, furthermore, made the manufacture of the battery so simple that every large road can repair and remake its batteries in a small space and without any mechanical skill. We have removed the mysteries that have hitherto surrounded the manufacture of the storage battery, and made its production as simple as that of almost any article of commerce. The ideal method of traction," he further says, "is a car propelled by self-contained energy. The cable, overhead wire, and the conduit system will never satisfy the spirit of human progress. That spirit can only be satisfied by each car being an independent unit and self-propelled. That such a car can be practically run and carry passengers by the aid of storage batteries no longer admits of any doubt in view of our experience with the car on Fourth-avenue, in St. Louis, and in Brussels. The only obstacle, therefore, that seemed to be in the way, or, rather, the only question or doubt, was as to its expense; and that expense was owing chiefly to the high price of the storage battery; but even this obstacle has been overcome by the methods lately invented by this company for manufacturing the storage battery cheaply. Up to a very recent date, the amount of storage battery required for a car cost more than the horses. This company is now prepared to replace the horses by storage batteries for a price much less than the cost of the horses. This fact alone, as every engineer will understand, removes the last remaining obstacle to the universal adoption of the storage battery system."

Resistance at Low Temperatures.—Some interesting researches have just been made into the diminution of electrical resistance of copper at a very low temperature, by M. Wroblewski, with reference to the statement by Clausius that the resistance of chemically pure copper should be proportional to their absolute temperature. The result of his experiments go to show that the electrical resistance decreases not only in proportion as the temperature is lowered, but even more quickly than this, and that a point at which the electrical resistance will be absolutely done away with can be obtained by means already known. It is certainly astonishing to think that a wire which will at ordinary temperatures carry only 1 or 2 amperes at a low temperature could be made to carry, say, 100 amperes. The means which M. Wroblewski took advantage of for producing an extremely low temperature was that of evaporating hydrogen at the temperature of its solidification, by which a rapid and intense abstraction of heat is produced. The coils employed were wound of double silk-covered copper wire, having a diameter of 0·025 millimetre, and guaranteed 98 per cent. conductivity. The coils had a resistance of between 3 and 20 Siemen's units at ordinary temperatures. These had to be plunged in liquified oxygen and nitrogen, which M. Wroblewski found were among the most perfect electric insulators. The resistances of the coils were then measured by the Wheatstone-Kirchoff method at various temperatures—namely, the temperature of boiling water, ordinary temperature, the temperature of melting ice, the temperature of boiling ethylene at atmospheric pressure (– 103deg. Cent.); the critical temperature of nitrogen (– 146deg. Cent.); the temperature of boiling nitrogen under atmospheric pressure (– 193deg. Cent.); and a temperature nearly that of the solidification of nitrogen (– 200deg. Cent. to – 202deg. Cent.). The results are given in the following table, in which T is the temperature, R the resistance in Siemens units, and a the co-efficient of variation of resistance between two consecutive temperatures:—

Coil I.			Coil II.		
T. Deg. C.	R.	a.	T. Deg. C.	R.	a.
+ 100	5·174		+ 23·75	19·251	
+ 21·4	3·934	0·004365	+ 23·75	17·559	0·004057
– 21·4	3·614	0·004136	– 103	9·848	0·004263
– 103	2·073	0·00414	– 146	6·749	0·004104
– 146	1·360	0·004588	– 193	2·731	0·004869
– 193	0·580	0·004592	– 201	1·651	0·007638
– 200	0·414	0·006562			

It will be seen from these figures that the resistance approaches zero more quickly than the temperature approaches – 274deg. Cent.

Conversazione.—The President of the Society of Telegraph-Engineers and Electricians and Mrs. Graves held a conversazione in the galleries of the Royal Institute of Painters in Water Colours on Tuesday evening, the 10th inst., which was very numerously attended, it being estimated that as many as 600 persons were present. The Band of the Coldstream Guards, under the conductorship of Mr. C. Thomas, played selections of music, and added greatly to the enjoyment of the evening. The pictures afforded pleasant material for conversation, though it is to be regretted that they are still exposed to the deleterious effects of gas. Altogether, the evening was a very pleasant one. The following are a few of the names of those present that occur to us:—*Visitors:* Sir Edward and Lady Birkbeck, Capt. E. M. Shaw, C.B., M. Fontaine, Prof. Groves, F.R.S., Rev. J. Macnaught, Prof. Frankland, F.R.S., Geo. Berkeley, Prof. Vernon-Harcourt, Capt. W. J. L. Wharton, R.N., T. A. Highton, L. W. Courtenay, H. Perigal, Sir Philip Magnus, Don Arturo de Marcoartu, Prof. W. Hudson, Dr. Plimpton, Sir Arthur Blackwood, K.C.B., Capt. Adams, C. Hawksly, G. J. Symons, F.R.S., J. Wimshurst, Dr. Tison, Wolfe Barry, Dr. Radcliffe. *Members*: Sir W. Gurdon, Sir David Salomons, Bart., Sir Henry Mance, C.T.E., Sir Douglas Galton, K.C.B., F.R.S., Prof. S. P. Thompson, F.R.A.S., Prof. G. C. Forster, F.R.S., Prof. Forbes, F.R.S., Prof. W. G. Adams, F.R.S., Prof. J. Perry, F.R.S., Prof. W. E. Ayrton, F.R.S., Prof. D. E. Hughes, F.R.S., Alexander Siemens, W. Crookes, F.R.S. W. H. Preece, F.R.S., Capt. H. Sankey, R.E., Col. Hamilton, R.E., Dr. J. H. Gladstone, F.R.S., Bernard Drake, Augustus Stroh, E. March Webb, Major C. F. C. Beresford, R.E., F. H. Varley, Louis Lœffler, J. N. Shoolbred, J.

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Hookey, F. T. B. Daniell, C. F. Kierzkowski-Stewart, W. M. Mordey, H. Benest, G. C. Fricker, Dr. Baur, M. Heaphy, Walter T. Glover, Captain Lugar, W. Lant-Carpenter, J. W. Swan, C. H. B. Patey, C.B., Capt. C. A. M'Evoy, Major-Gen. E. R. Festing, F.R.S., Dr. J. Hopkinson, F.R.S., Shelford Bidwell, F.R.S., Major-Gen. C. E. Webber, C.B., R. P. Sellon, C. E. Spagnoletti, W. H. Snell, W. B. Esson, F. Higgins, Dr. Walmsley, Dr. Steet, Captain G. W. Addison, R.E., F. Despointes, J. Farquharson, Charles Gerhardi, Dr. Oback, R. Waring (of Pittsburgh, U.S.A.), R. E. Crompton, R. K. Gray, Dr. G. A. Fleming, M.D.

Bradford.—The Bradford Corporation, in view of their scheme for erecting a central generating station in Bolton-road, for providing a regular supply of electric lighting and power for Kirkgate, Market-street, and places in the immediate vicinity, have recently issued a circular to occupiers of business premises in the central portion of the borough inquiring whether such occupiers would be disposed to take a supply of the current regularly for a stated period, suggested as three years. So far there has been a fair response to the inquiry, though it is somewhat early to enable the Corporation to say to what extent the experiment is likely to succeed. In addition to places of business, the free library, the markets, and other public buildings in the neighbourhood of Kirkgate are to be provided with electric light. It is proposed to make the supply continuous, except between 1 a.m. and 5 a.m., unless otherwise arranged. With respect to price, the Corporation have determined to adopt an alternative system of charge for incandescent lamps—namely (1), 5d. per unit, the Corporation to supply meters, if desired, at a rental of 10 per cent. on the cost; (2) by an annual charge of 20s. per lamp of 16 c.p., irrespective of the actual hours of lighting. The charge for the supply to arc lamps is to vary with the illuminating power of the lamp as required by the consumer at the rate of 5d. per unit. Ten units with incandescent lamps of 16 c.p. produce an amount of illumination equal to about 1,000 cubic feet of 15-candle gas. It is pointed out that the price is unavoidably higher at first than gas at its present low rate in Bradford. But against this are to be set the advantages which the electric light has over gas. The Corporation propose to carry the supply up to the buildings, the internal fittings being provided by the consumer.—At the meeting of the Town Council on Tuesday the Gas Supply Committee recommended the appointment of Mr. Sydney Baynes as clerk of works in connection with the electricity works, at a salary of £150 per annum, and then came a question æsthetical. Mr. Bottomley asked whether it was the intention of the committee to erect a brick chimney at the electrical works instead of a stone one. He was of opinion that a brick chimney would be very unsightly, and the Corporation had already prohibited the erection of a brick chimney by a certain firm in Bradford. Alderman F Priestman (chairman of the committee) said it was quite true that the committee were about to erect a brick chimney, and he thought they would be able to show how beautiful a brick chimney could be made to look. He believed that the handsomest chimney in the district was of brick, and undoubtedly for a mill a brick chimney was better in point of construction than a stone one, and he did not know why it should be thought that a uniform grey stone was necessarily the handsomest kind of structure which could be adopted. Eventually, if the electric installation should prove successful, the roof of the works would be raised, and the chimney would be built round for a considerable height, and only a portion of the chimney would be exposed to view. It was better to build the chimney as proposed rather than build an expensive stone chimney.

Nominal Horse-Power.—There are few technical terms which have so little real meaning as that represented by the letters N.H.P. It is not possible for any definite value to ever be assigned to this term independent of steam pressure, but a greater accuracy might easily be obtained in the relative value of the term as between engines of different makers. The following attempt, which has been made in the *Practical Engineer*, to roughly standardise this expression for commercial usage may prove useful :—"Nominal horse-power" is a term used to give an approximate idea of the commercial value of an engine, but has no fixed relation to either the actual or indicated horse-power exerted, but is essentially a conventional term, and is frequently determined simply from the size of the cylinders, leaving out of the question such variable factors as steam pressure, speed, &c. As no universal rule has ever been adopted, and as each maker has his own method of computation, the greatest differences in the calculated n.h.p.'s of different engines of the same power may often be found. In marine practice a common rule for compound engines is to allow 30 circular inches of cylinder per n.h.p. That is, $\text{N.H.P.} = \frac{d^2 + D^2}{30}$, where d = diameter high-pressure cylinder, and D = diameter low-pressure cylinder. If the other factors affecting the power developed depended on the diameter of the cylinder, this rule would be a fair one. But it is evidently misleading as it stands, for two engines may have the same cylinder diameter, but very different cylinder lengths. By introducing another factor, the piston speed, we might get a closer approximation; but the piston speed depends upon the supply of steam, and, therefore, if we want a close approximation we must base our estimate upon the boiler capacity, as well as upon that of the engine. A modern writer has given the following rule for finding the "estimated" h.p. of compound marine engines :—$\text{E.H.P.} = \frac{D^2 \times \sqrt{p} \times R \times S}{8{,}500}$, where D = diameter low-pressure cylinder, p = boiler pressure, R = number of revolutions per minute, S = stroke of piston in feet. This formula is evidently nothing but a means of approximating the indicated h.p. of the engine; but it certainly is a much more reliable criterion of the commercial value of the engine than the n.h.p. calculated from the cylinder diameter would have been. The need of some universal formula which will give an idea of the commercial value, and also of the real capability of the type of engine, is becoming more pressing now that the triple expansion engine, with its high pressure and speed, is so rapidly coming into prominence. Also the fact that certain charges made against ships are based upon the registered n.h.p. of their engines makes some means of determining this function a necessity. A rule that seems to meet all the requirements was proposed by Mr. Macfarlane Gray, and is as follows :—$\text{N.H.P.} = \frac{1}{2}\left(\frac{D^2 \times S}{630} + F\right)$, where D = diameter low-pressure cylinder in inches, S = stroke of piston in inches, F = total width of fire-grate in inches, 630 = a constant. It is true that the result obtained by the use of this formula is the n.h.p. of the boiler and engine combined; but they are so mutually dependent that no accurate idea of the value of the engine can be obtained without considering the capability of the boiler.

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ELEMENTARY TESTING SUITABLE FOR ELECTRIC LIGHTING SYSTEMS.

BY THOMAS GRAY, B.SC., F.R.S.E.

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(Continued from page 583.)

THOMSON'S INSTRUMENTS.

Reflecting Galvanometers.—The most important peculiarity in the reflecting galvanometers introduced by Sir William Thomson is the lightness of the suspended part. The magnetic needles are made very small, and thus allow the wire forming the coils to be disposed round them in a very effective manner. These features are of great importance when sensibility and rapidity of action are required. Sensibility implies a small controlling force compared with the deflecting force produced by unit current passing the coil, and rapidity of action requires the period of oscillation to be short, the rate of subsidence of the oscillations great, and the zero of deflection definite. In Thomson's instruments the moving system is suspended by a single fibre of silk, and the rigidity of this fibre is so small as to be negligible in most cases. Hence, in accordance with the principles already discussed, the controlling force depends almost wholly on the strength of the magnetic field surrounding the needles and on the nature of the needle system. Take, for example, a single needle of magnetic moment, m, and suppose the moment of inertia of the moving system round its axis of suspension to be μ and the intensity of the controlling field to be H. Then the period of oscillation, P, of the needle, or the time which it takes to make a complete double swing, will be

$$P = 2\pi \sqrt{\frac{\mu}{m\,H}}.$$

Now, for sensibility, H must be small, and by the construction of the instrument m is necessarily small, hence μ must be small also. If the moving system consisted of nothing but the magnetic needle, μ would depend on its mass and its shape; being directly proportioned to the mass multiplied by the square of the length when the needle is moderately long compared with its thickness. The value of m, on the other hand, is for all ordinary needles very nearly in simple proportion to the mass of the needle; the length having very little effect unless the transverse dimensions of the needle is a considerable fraction of its length. From this it is clear that the fraction μ/m can be, within certain limits, made small by reducing the length of the needle. This is accomplished in the Thomson needle by using four short flat needles, placed edge to edge a little distance apart, instead of one four times the length. In the actual case, the moving system consists, at the least, of the magnetic needles and a mirror to indicate, by the reflection of a beam of light, the deflection of the needles. The problem is thus complicated by the fact that μ consists of two parts – the moment of inertia of the needles and that of the mirror. The effect of the mirror is made as little as possible by using a small size and constructing them of exceedingly thin glass. The mirrors used are about one centimetre in diameter, and weigh only about the hundredth part of a gramme. There are two kinds of these galvanometers in common use, known as "dead-beat," and "astatic" mirror-galvanometers respectively. In the "dead-beat" form, the moving system consists of one set of needles, which are attached to the back of the mirror, and give the simple system above referred to. The astatic form contains two sets of needles, and requires besides the needles and mirror, a frame to carry them. In the best form of these instruments this frame consists simply of a straight vertical wire of aluminium, just thick enough to bear moderately rough usage without becoming bent. The increase of μ due to this wire is very slight.

"Dead-beat" Galvanometer.—The coil of this galvanometer consists of a single bobbin of well insulated copper wire, circular in front or back elevation, and of the form shown in Fig. 28 in longitudinal section. The number of turns of wire on the bobbin and the size of the wire used depend on the purpose for which the instrument is intended, but in all cases the diameter of the wire should be varied from the centre to the outside of the coil in such a way that at any layer it is nearly proportional to the diameter of the central ring of that layer. This method of winding is adopted in order that when a current is passed through the coil, the rate of fall of potential along the wire forming the coil is at any point proportional to the turning couple exercised on the needle by unit length of the wire situated at that point. This arrangement of the wire gives the greatest turning couple on the needle for any E.M.F. on the terminals of the coil, and hence for general purposes, and in galvanometers specified to have a certain resistance, it should always be, as nearly as practicable, adhered to. In some special cases where the resistance of the instrument is a matter of indifference, but the number of turns in the coil important, better results are obtained by using wire one uniform thickness throughout. Such cases will be considered in their proper place. The proper form for the central line of the cross section of any layer of wire was shown by Thomson to be expressed by the equation—

$$x^2 = (a^2\,y)^{\frac{2}{3}} - y^2$$

where x is measured from the centre along the axis of the coil, and y is any ordinate measured from and at right angles to that axis, and a is a constant for each layer which is equal to the value of of y when x is zero. The diameter

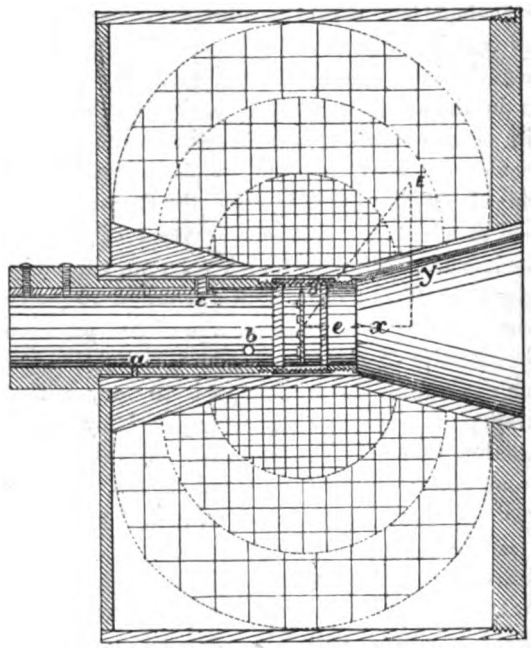

FIG. 28.

of the wire should be proportional to a to obtain the maximum deflection for any E.M.F. on the terminals of the coil. The forms of the layers, as given by the above equation, are shown by the dotted lines in Fig. 28. The usual practice is, as indicated by the squares in the figure, to wind on several layers of each of three or four different thicknesses of wire, the wires being so chosen that the aggregate resistance will be equal to that specified for the coil. The shape of the outside of each of these sections of the coil is made as nearly as possible the theoretical figure; but very close accuracy is difficult, and is not important. The proof of the above equation may be easily obtained as follows:— Let E be the cross section of any turn of the coil, x and y its co-ordinates. Then the axial component of the field, or the intensity of the field in the direction of the axis of the coil, produced by unit length of wire at E, through which unit current is flowing is—

$$\frac{y}{(x^2+y^2)^{\frac{3}{2}}} \quad \ldots\ldots \quad (1).$$

Now, the layer of wire which produces per unit length the same axial component, must have $y/(x^2+y^2)^{\frac{3}{2}}$, equal to a constant, equal to $1/a^2$, let us suppose. Then we may write:—

$$1/a^2 = \frac{y}{(x^2+y^2)^{\frac{3}{2}}} \quad \ldots\ldots \quad (2)$$

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$$\text{or, } x^2 + y^2 = (a^2 y)^{\frac{2}{3}};$$

$$\therefore\ x^2 = (a^2 y)^{\frac{2}{3}} - y^2.$$

We thus see that Thomson's equation expresses the form of a layer of wire, each part of which is equally effective. We have still to consider the effect of passing from one layer to the next. Take the central ring of any one layer, and we have, putting $x = 0$ in equation (1), for the effect per unit length of the wire the square of the reciprocal of the radius. Hence, the rate of fall of potential along the wire must be proportional to this quantity, or the section of the wire must be as the square of the radius of the central ring—that is, the diameter of the wire must be as that radius. The graduation of the thickness of the wire, in the manner here indicated, has considerable advantage for galvanometers which are intended for general laboratory work, and especially for low resistance instruments intended for use in the circuit of thermo-electric junctions of almost zero resistance. For galvanometers which are intended mainly for use in the measurement of the leakage current through the insulation of telegraph or electric light circuits, the number of turns on the coil is the chief element to be considered. The resistance of the circuit being very great compared with that of the galvanometer, it is generally better to use wire of uniform thickness throughout.

The axial component, in C.G.S. units, of the magnetic field produced by one of these coils when an ampere of current is flowing through it varies between 70 times the square root of the resistance in ohms for a coil of about 5,000 ohms resistance, to 140 times the square root of the resistance in ohms for coils of about one ohm resistance.

The mirror and needles of this galvanometer are suspended in the centre of the bobbin inside a small cylindrical cell formed at the end of a plug, which fits the central tube of the bobbin. The cell is formed by a thin brass tube, *d*, screwed in the inside so as to fit a corresponding thread cut on the end of the plug, a glass end fitted into the plug, and a lens, *e*, fitted into a brass frame which screws into the tube, *d*. The mirror is ⊔ shaped, nearly fits the tube, *d*, round its circular edge, and is suspended from the top of *d* by a short fibre of silk attached to the middle of its straight edge. The width of the cell can be varied by screwing the plug and the lens frame more or less into the tube *d* until the friction and inertia of the confined air in this cell so damps the vibrations of the mirror as to make it come almost instantly to rest when deflected. The plug is held fairly and securely in position, in the bobbin, by means of three fixed feet, two of which are shown at *a* and *b*, and a spring foot, *c*, vertically over the centre of the triangle formed by the other three. For use in the Wheatstone bridge, and for other similar purposes, where a quick acting and a sensitive galvanoscope is wanted, this is the most suitable form of galvanometer at present available. The form of the complete apparatus with lamp and scale as now manufactured, under Sir William Thomson's own supervision, by James White, of Glasgow, is shown in Fig. 29. In this figure the complete apparatus for the Wheatstone bridge test is shown. A is a battery of three small secondary cells, B is a scale of half millimetres and fifty centimetres long, C is the glass funnel of a paraffin oil lamp placed behind the scale, D is a dial box of resistance coils, with two auxiliary sets of coils between I and J and J and K, E is the galvanometer, F is a bobbin of wire which is being tested, G and H are two reversing keys. The terminals of the battery, A, are connected to the front terminals of the key H, and the back terminals of that key are connected to the terminals I and K of the box. The terminals J and L of the box are connected to the front terminals of the key G, while the back terminals of that key are connected to the two terminals of the galvanometer. The ends of the bobbin, F, are put in the terminal screws L and K. By this arrangement it will be seen that either the direction of the current through the box or the direction of the current through the galvanometer can be changed independently of each other. For the sake of clearness, the wires are shown in the figure passing directly to their respective terminals, but in actual practice the two battery electrodes, from the battery to the key, and from the key to the box, should be arranged so close to each other that the current through them does not deflect the galvanometer needle.

An objection to this galvanometer in the form here shown is, for some purposes, its comparative want of portability, because of the necessity for a separate scale and lamp, and it is sometimes difficult to obtain a sufficiently steady table to use it on. A very portable form can be made, however, by dispensing with the lamp altogether and using a plane mirror, the reflection of a short scale in which can be viewed either directly or by means of a small telescope. The effect of vibration on the mirror can be almost completely annulled by suspending the coil by means of rubber bands from any convenient support, or from a frame supplied with it.

For the estimation of the relative values of currents by the deflection of the galvanometer needle, the suspension of the mirror and needle by means of a very short fibre, as is the case in the instrument above described, is unsuitable. The rigidity of so short a length of even single silk fibre is not generally negligible in comparison with the other forces involved, and hence the imperfect elasticity of the fibre causes the deflection to gradually increase with time, thus rendering great accuracy impossible. For many purposes, however, the very light moving system, which is used in these instruments, is such an advantage that it is advisable to arrange the coil in two halves, and suspend the mirror and attached needles by a long fibre passing down between the coils. The arrangement for obtaining the cell for the mirror have then to be modified, and generally the action is not quite so perfectly "dead-beat," but still the rate of subsidence is much greater than it is in most forms of the "astatic" galvanometer, which instrument we will now describe.

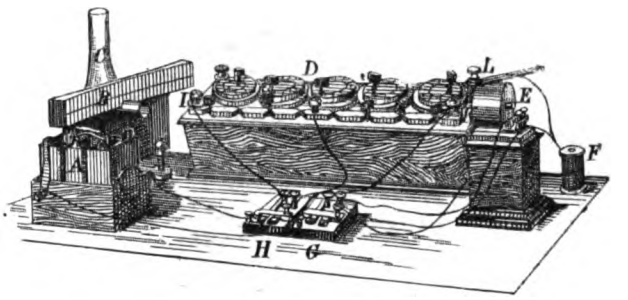

FIG. 29.

Astatic Galvanometer.—In this instrument the double-needle system as introduced by Nobili is applied to the small needles and light mirror used in the "dead-beat" instrument. The needle system consists of two sets of small flat magnets, each arranged to form a disc-shaped needle of about one centimetre diameter. One of these sets of needles is generally carried on the back of the mirror, and the two sets are held in a fixed position relatively to each other by means of a suitable frame. The frame is always made as light as possible, but has different forms according to the arrangement of the instrument. In an early form of the instrument, which, however, is seldom now adopted, there was only one coil, and it was wound on a single bobbbin—was, in fact, the same as that described above and illustrated in Fig. 28. The needles were in this case carried at the middle of the horizontal bars of a rectangular frame of aluminium wire, one of the horizontal bars of which passed along the axis of the coil, and the other parallel to it over the top of the coil. One set of needles was thus in the middle of the axis of the coil and the other set vertically above it, but outside the coil. The effect of the current through the coil was to deflect both needles in the same direction, but the outside set experienced much less force than the central set. A similar arrangement was sometimes adopted for carrying the needles when two coils were used, each set being carried on the centre of a horizontal bar passing through the centre of two separate coils placed vertically over each other. In this case the needles of each set were sometimes made of round bars, about one centimetre long and one-twentieth of a centimetre in diameter, arranged at the four horizontal edges of a cube of cork or pith. The mirror was in all these cases carried on a vertical stem projecting up from the centre of

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the frame above the coils. This arrangement, although convenient, and because of the comparative simplicity of the coils, cheap, added very greatly to the moment of inertia of the moving system, and thus took away very much of the advantage of the small needles and mirrors. In almost all the instruments now produced by the best makers the coils are made in two halves, and the needle system is mounted on a vertical rod of thin aluminium wire which passes down a vertical slot formed between the coils. A form of the instrument designed by the present writer, and which differs only in some details of its framework from the ordinary forms, is illustrated by means of a front view in Fig. 30. The object is to obtain an instrument which has a very high insulation from earth, which provides the means of readily varying the rate of subsidence of the oscillation of the needles, which is readily accessible in all its parts, and which can be used without a case. In this instrument the coils, *g k*, are made in two halves, and are either hinged or are held by a species of bayonet joint in a vertical plate, *e*, of brass, or, if the instrument is to be used for transient currents, of some good insulating material, such as vulcanite, or white marble soaked in paraffin. In this latter case the coils are also made of insulating material.

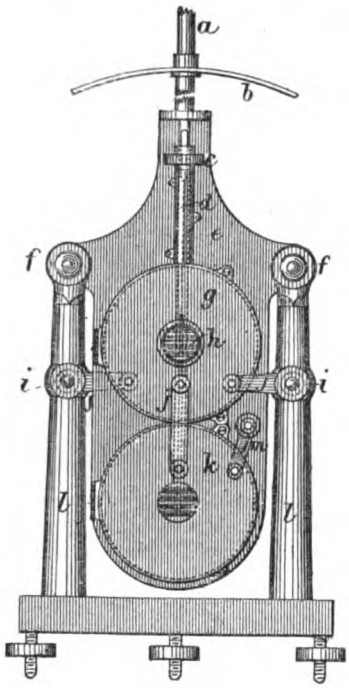

FIG. 30.

It may be interesting to notice here that recent experiments conducted at the writer's suggestion by Mr. Thomas Shields, M.A., in the physical laboratory of Glasgow University, have shown that white marble is an excellent insulator, and that when dried and soaked for a short time in melted paraffin it is little affected by moisture, and is extremely easily worked by ordinary instrument makers' tools. This material is cheap, and is much to be preferred to vulcanite for many purposes. The plate *e* is supported by two insulating pillars, *l l*, being clamped to two metal pieces, *f f*, fixed to the tops of the pillars. The terminals, *i i*, of the instrument are also fixed to these pillars, a little below the metal top when the plate, *e*, is of metal ; they may form a part of the metal pieces, *f*, when the plate is of insulating material. Each half of the coils is provided with two terminals, and they are joined in series or parallel, as may be desired, by means of straps, *j*, the connection from the front to the back pair of half coils being made by means of a rod, *m*, fixed to the plate, *e*, and fitted with a small terminal screw at each end. In the form here shown the mirror, *h*, is in the centre of the top coil, and carries one set of needles on its back, while the other set of needles is carried by a vertical wire fixed to the top set of needles, and is arranged to be in the centre of the lower coil when the mirror is in the centre of the upper one. A somewhat better arrangement of the coils round the needles can be made when the vertical rod is continued up through the top coil, and the mirror is placed in a separate cell with a plane glass front fixed in the plate, *e*, at a point a little above the coils. The needles and mirror are suspended by a silk fibre, which passes up through a slot in the plate, covered along the upper portion by a tube, *d*, the front portion of which can be removed for suspension purposes should the fibre break. A nut, *c*, working on a screwed rod, serves to raise or lower the needles, which can thus be readily lowered so as to rest at the bottom when the instrument is carried about. The "damping" effect on the needle is produced by means of plugs with glass ends (not shown in the figure), which slide into the central tube of the coil bobbins. By adjusting the distance of the glass ends from the needle, any desired amount of "damping" can be obtained. A controlling magnet, *b*, is provided, mounted on a vertical rod, *a*, above the suspension screw, and can be raised or lowered, or turned in azimuth so as to produce the amount and direction of controlling force desired. When a specially long suspension fibre is desired, which is advisable when very high sensibility is aimed at, the rod, *a*, on which the controlling magnet is mounted may be made a tube, and the suspension fittings placed at the top of it. It is convenient in this case to attach the suspension to the mirror and needle rod by means of a hook, so that it can be readily unhooked, as this simplifies the attachment of a new fibre.

Astatic galvanometers are generally made of high resistance and used for the measurement of very small currents, such as the leakage through the insulation of a telegraph line or cable, or from the leads of an electric light circuit to earth. It is not uncommon, when this leakage current is very small, for the controlling force due to the magnetic field to be so small that the rigidity of the suspending fibre plays an important part in limiting the possible sensibility of the instrument, and also the accuracy of its indications.

The torsional rigidity of a silk fibre averages about ·0015 C.G.S. units per centimetre of its length, and hence in a suspension five centimetres long the rigidity will be about ·0003 of the same units. Now, let C be the current flowing through the coils of the galvanometer, K a constant depending on the coils, I and I^1 the intensity of the magnetic field at the upper and lower needles respectively, m and m^1 the magnetic moment of these needles, τ the torsional rigidity of the suspension fibre, and θ the deflection produced by the current C. Then we have

$$C = K\left(\frac{Im - I^1 m^1}{m + m^1}\tan\theta + \frac{\tau\theta}{(m+m^1)\cos\theta}\right).$$

When the needle system is perfectly astatic, $m = m^1$, and the equation reduces to

$$C = K\left(\frac{I - I^1}{2}\tan\theta + \frac{\tau\theta}{2m\cos\theta}\right);$$

and for the small deflections used with these instruments may be written $C = \frac{1}{2} K\theta(I - I^1 + \tau)$.

From this equation, we see that the fibre becomes an important element when τ/m is not small compared with $I - I^1$. In very sensitive instruments $I - I^1$ varies from about ·01 to ·001, and in the Thomson form of needle m is approximately unity. Hence, the effect of the fibre, relatively to that of the magnetic field in controlling the deflection, may be about in the ratio of ·0003 to ·005; or, 1 to 17. This effect of the fibre would be of no importance were it not for the fact that its elasticity is very imperfect, in consequence of which the deflection apparently gradually increases, thus rendering it difficult to tell exactly what the true deflection is. We may assume, therefore, that for the Thomson astatic instrument the value of $I - I^1$ should not be made less than ·01. This is equivalent to saying that the current required to produce a motion of one-half millimetre division of the spot of light reflected from the mirror on a scale one meter distant from it should not be less than 10^{-10} amperes for a galvanometer of about 5,000 ohms resistance. When higher sensibility than this is required the fibre should be made much longer, and if possible m should be made larger. Other forms of galvanometer, designed by the present writer with the view of pushing the reliable sensibility of a galvanometer considerably higher, and which have been fairly successful for that purpose, will be described further on.

(To be continued.)

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PETER ROBINSON'S.

London is so big that an installation of the nature of a central station, and quite as large in itself as the lighting arrangements of many an American town, can be hidden away in one corner of its streets. The installation at the well-known costumiers, Messrs. Peter Robinson and Co., is one of the largest combined arc and incandescent installations at present running in London, and almost equal in its size to the Italian Exhibition, comprising, as it does, 80 arc lamps and 400 incandescent, which will shortly be increased to 700 in number. The installation, in a smaller form, has been running for some eighteen months or so, and was carried out under the superintendence of Mr. Ernest G. Craven, A.M.I.C.E., 22, Great George-street, Westminster; it has since been added to from time to time, and now makes one of the most interesting private installations in London. In order to get entirely rid of noise, dirt, and vibration, the excavations for the engine-room were taken down two floors below the ground. Going down into this subterranean locality, under the courteous guidance of Mr. C. Wenham, who has the whole electric department under his control, we come upon the familiar whirl and rush of the machinery.

A fine and spacious engine-room is occupied on either side by two compound horizontal stationary Marshall engines of 20 h.p. nominal each, driving a line of shafting from which are run seven dynamos. The first is an Edison-Hopkinson shunt machine, whose current at 130 volts, of 144 amperes, is led off to charge a set of 54 large E.P.S. accumulators—31 L type. These have a large and handsomely mounted switch-board, made by the Electrical Power Storage Company, for regulating the discharge, and an automatic charging cut-out of Elwell and Parker is used to prevent back current. The next dynamo is a Phœnix machine, by Paterson and Cooper, compound-wound, giving 250 amperes at 65 volts, and used for running both incandescent and arc lights. The arc lamps for this circuit are of a new and very satisfactory type, recently brought out by Messrs. Paterson and Cooper, in which the feed is regulated by a friction-wheel. These arc lamps are made to run in parallel on the incandescent circuit. Another Phœnix dynamo supplies current for 400 incandescent lamps on a 100 volt circuit. Four other dynamo Phœnix arc machines feed three circuits of 13 or 14 arc lamps in series, one dynamo being a spare one. These give 630 volts and a current of 8·5 amperes, and supply 40 Pilsen arc lamps, which are made under royalty by Paterson and Cooper. Switch-boards are arranged for each of these circuits, lighting (1) the outside and the windows, (2) the counting-house and domes, (3) the costume-rooms and boys' department. Each of these circuits has its own ammeter and resistance, and can be switched on to the spare dynamo if required. Another main switch-board is used for the incandescent circuit, which can be either run from the Phœnix dynamo or from the accumulators, which are sufficient to supply 100 16-c.p. lamps. A Cardew voltmeter is used to regulate the pressure.

A separate compartment is arranged for the accumulators, with a partition between it and the engine-room. The boilers for this plant consist of two Marshall's locomotive boilers, 20 h.p. nominal, with water-heater fixed on a separate basement. A further boiler, of 25 h.p. capacity, is to be added at once. The behaviour of the Marshall engines and boilers has been remarkably satisfactory, both in running and in economy. Little or no trouble has been experienced, and the expenditure of coal is put down at not more than 2lb. of coal per h.p. hour.

One very interesting point is the method by which the mourning-shop in Regent-street is connected to the main building, which is on the other side of Oxford-street. Leave was obtained from the two parishes to take up the roadway of Oxford-street, and a 4in. iron pipe was laid, in which two cables of 19-10 insulated copper wire were drawn through. This supplies 30 arc lamps and 25 incandescent lamps in parallel. An electric bell wire is also drawn in the tube, and a tarred rope, by means of which, wrapped at one end with flannel, any damp can be cleaned out periodically, or further cables could be drawn through if required. The boot-shop and Oriental bric-a-brac shop at 212, Oxford-street is supplied from the main building with six arcs and 60 incandescent lamps. The pressure at the terminals for the incandescent circuit is 108 volts, giving about 101 or 100 at the lamps. Very little trouble is experienced with the running of the incandescent lamps, about 25 per cent. or even less of the number being replaced, indicating a four years' life per lamp, and they have never had but one fuse go—that was for a single lamp short-circuited by a screw.

The switches, made by Paterson and Cooper, are in boxes controlling each room or circuit; but greater satisfaction and convenience is felt with switches on every lamp, and this is being done with the later lamps, and many of the old ones have self switches in the holders. The holders throughout are screw sockets for Edison-Swan 16-c.p. lamps. The fittings were all specially made by Messrs. Verity and Sons, of King-street, the old gas fittings having all been taken down. They are for the most part three, four, or five-light combined gas and electric pendants; one light remains alight while the current is on, the others can be turned on or off with switches. Very great comfort and gain is obtained with the electric light, the comfort to the workers being very noticeable. The saving of goods is also considerable, gas both rotting and fading many of the fabrics. By the arc lights, goods can be matched at night as well as in the daytime, and the white-washing of the premises has not been needed this season. Messrs. Robinson and Co. are much pleased with the arc lamps working in parallel, supplied by Paterson and Cooper, finding it a great convenience to be able to turn off any number or to light up three or four only at pleasure, whereas with series lighting four or five at most could be turned off without danger to the rest. The whole installation is very complete and well arranged, and its success should prove an encouragement for other establishments of the same nature to adopt the light.

ELECTRIC FIRE ENGINES.

To the Editor of The Electrical Engineer.

Sir,—I read with some interest the paragraph in the current issue of your paper on the use of electric fire-engines. I have often wondered that firms making dynamos and motors have not given more attention to this subject.

It may interest your readers—though the information may be somewhat of a disappointment to the inventor to whom you refer—to know that the plan was tried on a practical scale in St. Petersburg, in August, 1881, by M. Tchikoleff.

In the experiments I refer to, a lead was taken from the Arcadia Music Hall, where the electric light was installed, to the banks of the Neva, and there the electric current was employed to feed an electro-motor actuating two pumps. The first pump was employed to raise water from the river to a tank, whilst the second, a force pump, was employed to force the water through a hose and jet in the usual manner.

The experiments clearly showed the advantages of this system. The motor and pumps might have been enclosed in a box of about 3ft. side; and appeared to be about as powerful as one of the ordinary steam fire-engines. The electrical energy, so far as I know, was not measured, so that I am unfortunately unable to give any figures. The advantage in transport through the street of a small motor and pump, instead of a steam fire-engine, and the simplicity with which the connections could be made, and the electro-meter set to work, compared with the trouble of getting up steam in an ordinary steam fire-engine, was clearly shown. The advantage of having terminals at each fire-plug in connection with conductors passing to a central station was dwelt upon by M. Tchikoleff, who also pointed out that until such a centralised system were adopted the plan could easily be carried out on a smaller scale wherever a continuous-current electric light installation was set up.

M. Tchikoleff calculated that the cost of delivering 12,000 litres of water per hour in the manner mentioned was from 4d. to 6d. per hour. Such an estimate is, however, very incomplete.

The credit of the application of electricity for this purpose would appear to be due to M. Tchikoleff.—Yours, &c.,

J. G. Lorrain.

Norfolk House, Strand, W.C., July 11.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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A letter awaits No. 28.

NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

ARCHITECTS.

Electric lighting in the immediate future will be, and must necessarily be, largely influenced by the attitude of architects. If in their judgment the introduction of such lighting aids them in producing a more attractive and a better lighted interior, assists in producing a *mise en scene* more in accordance with the tenets of the particular fashion that at the moment is the rage, then architects will undoubtedly for their own purposes introduce the light wherever and whenever possible. The word of the architect is law in many cases; his suggestions are supposed by his clients to be infallible, and as such to be followed out at whatever expense. If our contention is correct, one way of increasing business is by educating the architect. The public appeals to the architect, and the latter, if he knows, advises according to his knowledge; but, on the other hand, accepting that he so advises when he is ignorant of the whole subject, the advice must necessarily be somewhat on the lines, Don't at present interfere with the old-established systems of lighting; this new-fangled way is only in its infancy, and you will do better by waiting, as it will be more perfect by-and-by. The result is that a large mansion is built, but not at once provided with the electric light, and it may be this generation loses the business; for it is far more difficult to oust gas when the pipes are laid, and the chandeliers designed, made and fixed, than it is to substitute electricity for gas in the initial stages of the architect's work. The waiting for perfection argument is one of the most illogical and idiotic ever invented by the man utterly void of self-reliance. If we waited for the perfection of anything we should have to wait till the millenium, and that would be a little too long for the great majority. Steam-engines were used before they were perfected; indeed, if we reason from the Patent Office records, they are yet far from perfect.

There are a number of electric light engineers who, to ingratiate themselves with enquirers, do not fail to reiterate the statement that the gas fittings can be easily utilised for electric light purposes. The sooner a decided stand is made against this method of doing business the better. Gas fittings are not suited for electric light purposes, and if so used, are, at the best, only bad makeshifts. What we want to impress upon the architect is the suitability of the electric light for his purposes, and the advisability of providing for such a light from the commencement of his designs. When he understands its suitability and undertakes its provision, we have further to educate him in the necessary precautions and requirements of the system. Wires are not to be built into the walls haphazard, but should be so placed as to be harmless and easily accessible.

From all points of view, then, the influence of the architect is of the utmost importance to the progress

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of the industry. A certain percentage will always investigate and support a new departure if the investigation has been satisfactory; but it can hardly be expected that the ordinary architect will of his own free will take upon his shoulders the obtaining of correct information about a new science and its applications. He has now to be something of a geologist, a mechanician, a mathematician, and an artist, besides being familiar with the work of bricklayers, stonemasons, plasterers, carpenters, slaters, and all the other trades which are called in to take part in the building of a house. As a sanitary engineer he is supposed to have reached perfection, for whatever goes wrong in the manner of sanitation the fault is laid at the door of the architect. At the present moment, perhaps, the connection of the architect and the electrical engineer is almost entirely confined to electric lighting, but it is quite certain that this in the immediate future will be but one link in the connecting chain. One of our most eminent doctors not so very long ago gave reins to his imagination and described a perfect city—Utopia. We might attempt, but we should lamentably fail, to describe the part electricity is destined to play in our household economy. It should give us light—it should give us power. Why should it not lock and unlock all our doors, and secure our windows from burglarious attacks? Of course we cannot prevent the breaking of a pane of glass or of the panel of a door, but there is no difficulty in so arranging electric apparatus that no door or window can possibly be opened in the ordinary way. The expense to utilise the services of electricity will be comparatively small when the architect provides for its use from the first. There is no reason for door-knobs or keyholes; an electromagnet can form a key as efficient as any ever found out by Chubb. Indeed it would not be very difficult to provide an instantaneous punishment for anyone attempting to tamper with the fastenings of doors and windows, or at any rate to guarantee immediate detection. The vista of possible business when the applications of electricity becomes so general is entrancing, and its realisation depends upon the way we manage to educate the architect. Let him be recognised as a power, and be treated accordingly.

CORRESPONDENCE.

UNITED TELEPHONE CO. *v.* EQUITABLE TELEPHONE ASSOCIATION, LIMITED.

To the Editor of the Electrical Engineer.

Sir,—Having been under the impression that it was a gross impropriety to express an opinion on the merits of a case *sub judice* we have hitherto as far as possible studiously refrained from dealing in a public manner with the persistent efforts made on behalf of the United Telephone Co. to damage our interests in the eyes of the public as well as of their own shareholders and to try and intimidate those to whom we have supplied instruments. But as the Chairman of the United Company has not hesitated to make public, through his speech on 3rd inst., as reported in your issue of 6th inst., a legal opinion on the probable result (from his company's point of view) of the action now pending between the United Telegraph Company and ourselves, we think we need no longer hesitate to say that we have as much confidence in the result being in our favour as the United Company's solicitor professes to have on his side, and that we have the opinion of counsel, if not quite so eminent, at any rate as painstaking as the Attorney-General, that our instruments are not infringements on the United Company's patents. As regards our association fighting the case out, the solicitor of the United Company may certainly be complimented on his sagacity in this respect, and if our association is but a small company compared with the huge monopoly the United Company strives for, we can assure the latter that there are willing purses prepared to find the money to attempt, at least, to break down such a monopoly.—Yours, &c.,

A. E. C. Swinton, Director,
The Equitable Telephone Association, Limited.
July 7, 1888.

ELECTRICAL QUACKS AND GALVANIC BELTS.

To the Editor of The Electrical Engineer.

Sir,—With the object of exterminating electrical quacks and galvanic belt frauds, a subscription list has been started in order to publish in pamphlet form the excellent report and a portion of the correspondence on the above subject which has recently appeared in the columns of the *Electrical Review*, London. A committee is being formed in order to effectually carry out this benevolent scheme. I shall be glad to receive assistance in any way from any of your readers.—Yours, &c.,

J. Jerritt, A.S.T.E. and E., sec. *pro tem.*
Mutley, Plymouth, July 9, 1888.

[We are pleased to insert the above letter, and recommend the co-operation of our readers with the objects therein expressed.—Ed. *E. E.*]

DETECTOR FOR HOT BEARINGS.

To the Editor of The Electrical Engineer.

Sir,—In your issue of the 29th ult. Mr. Broadbent says that hot bearings should not occur. Very true; yet he will not deny that often, in spite of care, ships are "brought up" through this cause, and delay, expense, and trouble are the result. Again, the tendency to increase the speed of engines makes more than ever the "feeling" of crank-pins when running a matter of guesswork.

Still, I agree with him that to leave the replacing of fusible plugs, or anything to be done to a heating detector, after giving an alarm, is fatal to its reliability, and also that the alarm should be given at any *required* temperature when the heating is *beginning*.

I have, in conjunction with others, invented an instrument which has been manufactured by Messrs. Elliott Brothers, of St. Martin's-lane, London, who will be glad to show the same to anyone interested in the subject. This simple arrangement may be fitted in the top brass of a crank-pin, and connected by two wires to a small battery and bell fixed to the bottom of connecting rod. By a simple adjustment any temperature desired may be denoted, and when not only the whole but any *part* of the bearing is *beginning* to heat the bell will ring. It can be fitted to any bearing. The only attention required is the recharging of the battery, say, every six months. There is no complication, and it can only be put out of order deliberately.—Yours, &c., W. T. W. Thackeray.
9th July, 1888.

The Americans Use Them.—As soon as the Americans get hold of anything that will work, they apply it. All the improvements in dynamos and in motors have practically been rejected on this side of the Atlantic. We seem to make the improvements for the Americans to make use of.—*W. M. Mordey.*

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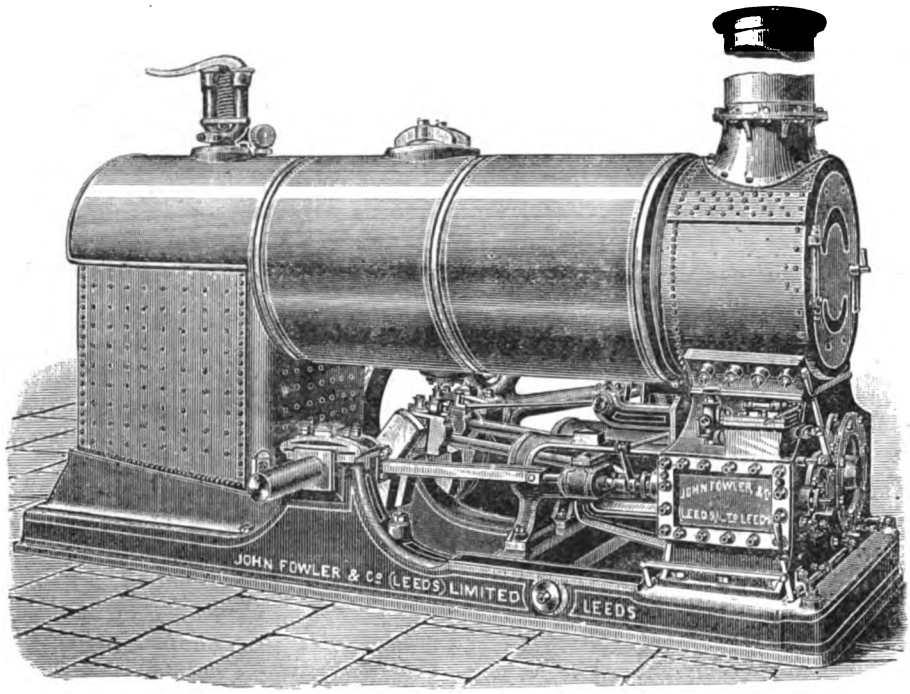
ROYAL AGRICULTURAL SOCIETY'S SHOW, NOTTINGHAM.

The Royal Agricultural Society's Show, held this year, for the first time in its history, at Nottingham, contains few exhibits of any great interest to electricians. In one department, however, as year succeeds year, there are exhibits specially fitted for the examination of the electrical engineer. We refer to the engines shown by the large engine firms. At the present time, four or five different types of engines are used for installation work. A small temporary installation is often run by a portable engine. Other installations derive their power from the semi-portable — undertype engines — while the larger installations have fixed engines. Then we have fast-speed direct drivers, for work requiring another class of engines; and where accumulators are used, gas-engines are also largely used. Engine makers have almost unanimously come to the conclusion that the so-called semi-portable undertype of engine is the one best suited to the present need of the electrical engineer, and they exhibit these engines as "admirably suited for electric lighting purposes." Upon examination of the exhibits excellent engines of this class will be found at the stand of Messrs. J. Fowler and Co., Messrs. Ruston and Proctor, Messrs. Ransomes, Sims, and Jefferies, Messrs. Robey and Co., Messrs. Marshall and Sons, and others, and it may be worth while just to pass these engines in brief review before our readers.

A technical description is not called for, inasmuch as the engines built by the firms we mention are known to be first-class productions; and because the makers have a reputation to consider, it may almost be taken for granted that their productions are from well-considered designs and from the best materials. It is absolutely impossible for us to say this or that engine is better than those of other makers. There are a good many considerations to be taken into account in determining "the best," and these considerations are such that no trial or series of trials being carried out or attempted will enable any man to come to an absolute decision upon this question. Time is a most important factor in almost all mundane affairs, and time tells a good deal more about the cost of maintenance than any other method ever devised. The very fact, then, that the productions of certain firms are preferred before others is almost conclusive testimony that experience shows these productions cost less in maintenance than those of competing firms. A stringent trial of engines, like that of last year by the society at Newcastle, brings out one that under the conditions then holding is shown to be somewhat better than the rest. Messrs. Davey, Paxman, and Co. then secured the much coveted prize, and the records of the society show other firms similarly successful in the past. This means that the engines of several makers are almost or quite equally good. And business must be obtained, not because of any great predominance, but by tact and attention to special details required for special purposes. We could wish, however, that engineers would agree as to some better method of indicating the power of an engine than by stating it to be so many horse-power nominal. Really, students are handicapped as far as possible in every direction—it would seem stupidly so, and for the sole purpose of keeping information from them. Knowledge is power, says the old adage; get knowledge, say the greybeards, but at the same time those who have the knowledge take care it is not easily obtained by others. The student soon finds out that horse-power nominal means anything or nothing, and that size of cylinder, length of stroke, or indicated horse-power are really what he should know. Most of the best makers reckon the normal work—that is, the work best suited for the engine is from 2½ to 3 times the nominal horse-power—in other words a 20 h.p. engine is supposed to be worked so as to give 50 to 60 i.h.p.



Messrs. Fowler and Co.'s 12-h.p. Semi-Portable Engine.

The value of the undertype engine in saving cost of foundations, minimising vibration, and in various other ways need not be dwelt upon here.

Messrs. J. Fowler and Co., of Leeds, show a 12-h.p. semi-portable engine, which is also specially constructed for electric lighting. This engine is similar to the one used last year at the Saltaire exhibition, which is now in use by Messrs. Laing, Wharton and Down in their installation at St. Pancras. The engine, which is herewith illustrated, is fitted with Hartnell's patent automatic expansion gear on both cylinders. Messrs. Fowler maintain this is the proper thing to do when the power given off by each cylinder is to be equal under varying loads, as is the case in electric lighting work. We are informed that by the method adopted of governing this engine it is incapable of exceeding by more than 1 or 2 per cent. its mean speed when the load is suddenly removed, and will not fall below the mean speed by a greater amount when the whole load is suddenly thrown on. In practice, a small fraction of 1 per cent. variation of speed begins to alter the degree of expansion, a result not obtained with ordinary governors. It will, however, be quite within the knowledge of our readers that every firm of repute that undertakes the construction of electric light engines pays special attention to the governing of the engines.

Messrs. Fowler and Co. also display a case of samples of "Tatham's" patent lead-covered cables and wires for all kinds of electrical work, telegraph, telephone, and electric

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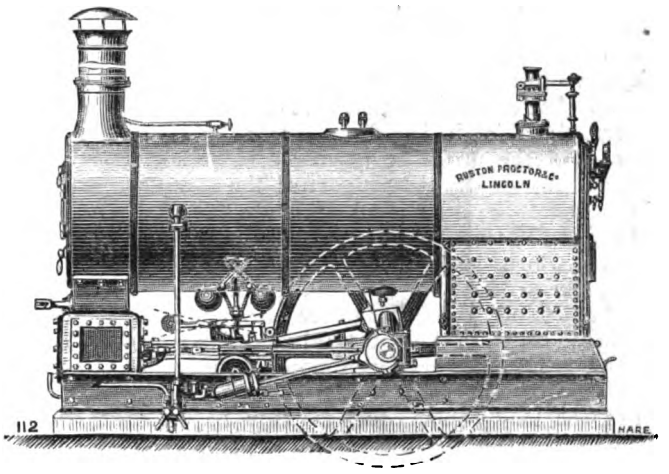
light, of which they are the sole manufacturers for Europe and the colonies. These cables are said to be specially suited for underground work of every description, being used in mines, the beds of rivers, docks, and for ordinary telegraph and telephone work. For lighting factories, chemical works and ships, these lead-covered cables have much to recommend them. The lead is put on continuously and not in short lengths, thereby greatly lessening the number of joints required in long lengths and large installations. The insulation of these cables is given as exceedingly high and of great mechanical strength. It is unaffected by heat. The telephone cables (1 to 104 wires in the same cable) are made on a patent principle, by means of which the troubles of induction and bad language are said to be removed, but in this place, while describing the exhibits at a Royal Agricultural Show, we must restrict our remarks, and reserve for future consideration the peculiarities and adaptabilities of this new insulating compound and method of protecting the conductors.

Messrs. Ruston and Proctor show a 16-h.p. nominal semi-fixed undertype engine, specially designed for the driving of dynamos. The high-pressure cylinder is 8in. in diameter, and the low-pressure 12¾in., both having a 16in. stroke. The most economical load of this engine is given at 40 h.p., the maximum as 48 h.p. Taking that seven 16 candle incandescent lamps are obtained from 1 i.h.p., this engine is powerful enough to drive a dynamo to give about 300 lamps, and in most cases this would represent a wiring of at least 500 lamps. These roughly approximate calculations can be applied in the case of all other engines



Messrs. Ruston, Proctor and Co.'s 16-h.p. Semi-Fixed Under-Type Engine.

mentioned. Each part of the engine has received special attention, and the makers are ready with good reasons why their particular method or material is to be preferred. Automatic expansion gear is fitted to the high-pressure cylinder, and great care has been taken to make the governing satisfactory. The boiler is of the multitubular type, and designed for a working pressure of 120lb.

NOTES ON DYNAMO CONSTRUCTION.

BY SYDNEY F. WALKER.

Thanks to the labours of the Hopkinsons, Silvanus Thompson, Kapp, and others, the construction of dynamo electric machines has now approached a definite stage; but much yet remains to be done. There is no recognised form of dynamo, although the Gramme, the disc, and the drum armatures are all free from patent rights. At present anyone wishing to take up the manufacture of dynamos is bewildered by the numerous forms of the article—all of them different, and each claiming to be *par excellence*, not only the best, but far and away superior to every other.

The following notes have been written with a view of clearing the ground as far as possible, and pointing out the practical advantages and disadvantages of each type. To begin, then, there is really very little to choose between the different patterns, provided that all are equally well made, and conform to certain conditions that will be detailed. The differences between the various types of machine, except where explained, are mere differences of detail, brought about in many cases by the wish of the designer to have something different to the Gramme so long as the latter held the field, and in other cases by the idiosyncracies of individual inventors. But the greatest diversities of ideas prevail in their construction. One man's aim has been to reduce the amount of copper used in his machine, and he will proudly tell you that he gets so many watts per lb. of copper. Another holds the opinion that the great desideratum for dynamos is, that they should run at a low speed; a third will tell you that he only uses wrought iron in the construction of his machines. One set of makers construct the armatures of their dynamos in the form of a long cylinder; another set, in the form of short cylinder; a third in the form of a drum; and a fourth in the form of a disc. One set of makers construct their field-magnets in the form of a single horse-shoe; another set, in form of a double horse-shoe; and a third have several horse-shoes. In the case of some makers, the machines of two, or even all, of the above types are made. One set of makers run their armatures at right angles to the line of the field-magnets, and others parallel with them, and so the changes go on.

It must be remembered that there are two parts to the problem in designing a dynamo, the electrical and the mechanical.

The useful output of a dynamo, as is well known, is the product of the largest current the dynamo is capable of furnishing × by the E.M.F. at its terminals when furnishing that current, and running at the highest safe speed if variable, or at the normal speed if the latter is constant. The E.M.F. at the terminals, as is also well known, is the total E.M.F. produced by the armature, less a charge measured by the product of the resistances of the armature and series wire on field-magnets, where there is one, × by the current. The total E.M.F. of the armature is proportional to the product of the speed, the number of turns of wire on it, and the number of lines of force passing into it across the space occupied by the copper wire. Using Mr. Kapp's formula – $Ea = \frac{NTnZ}{1{,}000{,}000}$ where Ea = total E.M.F. generated by the armature; in volts, N T = the number of turns of wire on the armature, reckoned all round its periphery; n = the number of revolutions per minute; Z = the number of Kapp's lines passing into the armature. Mr. Kapp has been taken very seriously to task for his notation, but as manufacturers want to know the volts they may expect, and care very little for absolute units, most of them incline very strongly to Mr. Kapp's views on the subject. It is evident from the formula that a given E.M.F. may be generated by any combination of the above quantities that is convenient. Thus, you may have a very small dynamo with a very light armature running at a very high speed. The best illustration of this is the dynamo attached to Parson's steam turbine, which runs at some 9,000 to 12,000 revolutions per minute; but it appears to the writer that you cannot easily get the full benefit of these very high speeds. Although the dynamo and engine of Messrs. Parsons' works remarkably well and form a striking instance of the possibility of using very high speeds, it is doubtful if they are able to obtain their full advantage in the reduced size of the machine, and it is also very doubtful if the machines are as efficient. The writer understands that the core of the armature heats considerably, as naturally might be expected under the very rapid alternations of magnetism. This could, of course, be remedied by having no iron in the armature, though that would lead to a loss from the increase of the resistance of the magnetic circuit. It could be more efficiently disposed of by making the core of the armature stationary, and allowing the wire only to revolve, or by arranging a special design. When using these very high speeds, too, it is necessary to provide for the greatly increased friction; this difficulty appears to have been quite overcome in Messrs. Parsons' apparatus, and the whole arrangement shows great care and skill in designing and workmanship.

You may also have a very powerful magnetic field, the factor Z being very large, while the others remain small. This, however, necessitates increased size in the dynamo. In order that Z may be large, the quotient of

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the exciting power, divided by the magnetic resistance, or $\frac{P}{R}$, must also be large. This means that P must be very large or R very small. You can only accomplish either of these ends by making your machine big and heavy. It has been established that iron, even of the very best quality, will only transmit a certain number of lines of force without beginning to increase its magnetic resistance; and, moreover, it is necessary that its cross section shall be large in order that its magnetic resistance shall be low. Secondly, in every dynamo the winding-space for wire is limited by the construction of the machine, so that if greater magnetising power is required it can only be obtained by increasing the dimensions of the winding-space, and usually with it those of the entire machine. Even in those few cases where it is possible to wind an increased number of turns on without alteration, it must be remembered that as each layer is wound further and further from the core its inductive effect upon the iron becomes less and less. The above remarks as to size apply equally to the armature and to the field-magnets, as they both have to accommodate the same number of lines of force. There is also a practical limit to the number of lines of force per square inch that you can advantageously make use of in the core of the armature, owing to the heating due to the alternations of the direction of magnetisation; and in practice it is found that dynamos work better the lower the strength of magnetisation. And, thirdly, the required E.M.F. may be obtained by means of a weak field and moderate speed, if the number of turns of wire on the armature are large; but this only within certain limits, and there are many practical objections to it. In the first place, in order to increase the number of turns, you must either decrease the size of the wire on the armature, thereby decreasing the output of the machine, as the armature will now only furnish a smaller current than before without unduly heating; or you must increase the number of layers of wires, in which case, as you throw the iron core of the armature further back from the pole-pieces, and at the same time decrease the volume of iron in the core to make room for the additional layers of copper wire, you add very considerably to the resistance of the magnetic circuit. Further, whether you decrease the size of the wire on the armature or increase its length, you increase the armature-resistance, and with it the charge upon the initial E.M.F. generated. The apparent added resistance of the armature, due to self-induction of its coils, and with it the working resistance, is also increased, as is the sparking at the brushes, all being sources of loss. The best type of machine would therefore evidently be that in which Z was large and the other factors comparatively small; but if we go too far in this direction we may buy our apparent efficiency too dearly.

Here it should be noted that large machines and small ones are not exactly on all fours in this matter. Where we are consuming, say, 100 h.p. or 1,000 h.p. a saving of 5 per cent., or even 1 per cent., may be worth having if not purchased too dearly—that is to say, if the interest on the increased cost of the machine to enable us to make this saving does not exceed the annual cost of the power saved. In small machines, using, say, 5 h.p. or 10 h.p., a saving of even 5 per cent. after a certain efficiency is attained would in most cases be too dearly bought, owing to the increase of the size and delicacy of the machine necessary to enable the extra saving to be attained. The increased cost in large machines also would be principally represented by metal, upon which not much labour has been expended, while in small machines more of it would be for labour. The manufacturer will, therefore, probably design his machines for large work, large; and in those for smaller work he will strike a mean, getting his speed as high as he can, his magnetic field as strong as possible, and making up with turns of wire; but the test in each case will be the cost of production. The price he can obtain for his finished machine is beyond his control, so that the amount of profit he is able to make will depend upon the design of his machine from a structural point of view. A saving of copper on the armature will be no gain if the same money value or more is lost by the increased cost of machining the iron work; and again, though iron costs less than copper, there will be no saving if the value of the extra weight of iron exceeds that of the copper displaced. The limit, apparently, to iron displacing copper is reached when the value of the extra weight of iron, plus the value of the extra machining and handling, plus the value of driving power saved, if any, equals that of the copper displaced, plus the saving in winding, if any. It will be evident, also, that the value of the increased efficiency will vary very considerably under different conditions, such as the price of coal, the cost of attendance, &c.

One of the first points a manufacturer has to decide is the form of his machine. Shall the armature be a long cylinder, a short one, a drum, or a disc? Shall the field-magnets be single, horse-shoe, or double, or shall the dynamo be multipolar? Shall the axis of rotation of the armature be parallel with the field-magnets, or at right angles? These points may seem trivial in themselves; but they will often make a considerable difference in the cost. Upon the form of the armature and field-magnets the magnetic resistance depends, and therefore, in part, the efficiency of the machine. The magnetic resistance depends directly upon the length of the magnetic circuit, and the materials of which it is composed, and inversely on its cross section. Thus air, as is well known, has an enormously greater resistance that iron, consequently everything is done to reduce the length of the air space in the direction of the lines of force, and to increase its cross section. This points to a long bobbin and to very few layers of wire between the core and the pole-pieces, and those as thin as possible. In many modern dynamos, only one layer is used for incandescent machines. In the Pacinotti form, projections on the core are brought right up the pole-pieces, allowing, of course, the usual clearance, but here an unforseen source of loss has crept in, owing to the heating of the pole-pieces, due to the teeth of the armature causing too rapid variations of the resistance in that part of the magnetic circuit. To remedy this, it has been necessary to reduce the diameter of the armature, leaving a larger air space, and thereby neutralising at least part of the advantage gained. It remains to be seen if an armature wholly of iron has this defect. The armature recently designed by Mr. Charles Lever, in which the teeth are run in grooves in the pole-pieces, carries the Pacinotti principle a step further, but would apparently be subject to the same faults as the latter, and in addition, to the structural objection that the whole machine has to be very much more carefully fitted, and is therefore more expensive.

But the long bobbin cannot easily be arranged with machines in which the armature runs parallel with the line of the field-magnets, without either making some special arrangement for the commutator, such as placing it outside the machine, or by lengthening the whole machine, in which case you have increased your magnetic resistance again. This would appear to argue in favour of those machines in which the axis of rotation of the armature is at right angles to the line of the field-magnets, and for this reason doubtless many manufacturers have adopted that plan. Before deciding definitely to adopt the long bobbin, and the armature at right angles to the field-magnets, a maker would do well to go into the question of the mechanical construction of the machine, which plan will work out best in the fitting shop, because it may easily happen that in order to obtain the advantages of a certain form of bobbin he will have to pay more for fitting, and he may also discover that all or nearly all that he can attain by means of that particular bobbin can be obtained equally as well by means of another form by the simple process of neutralising a loss in one direction by a gain in another. The problem to be solved is, to construct a dynamo as cheaply as those in the market, and as efficient—that is to say, to get as much work as possible out of a machine, costing a certain amount for the materials and labour, and to attain the work with as little loss between the driving pulley and the terminals of the machine as possible. If we produce a machine that is cheap, but that obliges the purchaser to consume more coal than another machine, our machine may not be really cheap after all. But, on the other hand, we must be careful not to so complicate our machine in obtaining so-called increased efficiency that we make the extra cost of attendance due to this complication greater than the amount saved by the increased efficiency, nor by increasing

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the return at the terminals of the power given to the pulley to increase the cost of repairs to the machine.

Five per cent., or even 10 per cent., extra efficiency, would be dearly bought if the repairing account were largely increased in consequence. A machine giving 80 per cent., or even less, that would run year after year with little or no trouble, would be more efficient in the true sense of the term than one giving 95 per cent. or 98 per cent., that constantly needed repairing, or in which the repairs were expensive when they did come. It is an old rule in practical work that the last 5 per cent. efficiency takes a great deal of keeping up, whether it is in an engine, a pump, a dynamo, or any other apparatus. It usually depends upon some special fitting requiring special men—and often very expensive ones—and special tools to repair it from time to time.

The best machine is always the one that can be easiest repaired, other things being the same. We must also be careful not to err on the opposite side: not to construct our machine mechanically weak, or in any way sacrifice the durability of any of its parts for the purpose of making a cheap machine. The real test is the working cost of the whole apparatus.

Let us consider what are the losses or charges to which we have to submit. First, we have friction, due to the spindle of the bobbin revolving in its bearings. This will vary directly with the weight and with the speed Here, then, is one argument against both long bobbins and very high speeds, since the former must necessarily be heavier, or else some of the advantage given by length is lost by the decreased section of the core. Next, we have the charge for magnetising the field-magnets, for providing the lines of force. Unless we pay this toll we can have no current furnished. The charge under this head varies inversely as the magnetic resistance. The more we can reduce this the less power we require to do certain work, or to produce a given number of lines of force. This resistance, as Mr. Kapp has shown, consists of three parts: the resistance of the field-magnets and their yoke, the resistance of the core of the armature, and that of the air space and copper wire. Of these, the resistance of the air space is enormously greater than that of any other part for a given section; and further, cast iron, of which standards and pole-pieces are usually made, has a higher resistance than wrought iron. The resistance of each of these varies directly with their length in the direction of the lines of force, and inversely with their cross section. This would point again to a long bobbin, and to short and thick magnets, provided the necessary exciting power can be placed on them.

(To be continued.)

DETECTOR FOR HOT BEARINGS.

With reference to our note upon the question of detectors for hot bearings, we have received a letter from Mr. W. T. W. Thackeray, which we print in our correspondence columns, calling attention to patent No. 3827 granted to him in last year, in conjunction with the widow of H. R. Landon, electrician, and the widow of John Richardson, instrument maker, for apparatus which will enable the beginning of any slight increase of heat in the bearings to be noticed before any real damage in done.

The apparatus consists of a reservoir of suitable shape in connection with a "Bourdon" tube, the reservoir and tube being filled with gas or liquid having expansive properties. The free end of the "Bourdon" tube may be connected to a lever for multiplying the motion caused by expansion or contraction of the liquid or gas, and the lever can be made to pass over one or more electrical contacts in connection with an electric bell. The lever can be arranged, if preferred, to relieve a spring, setting in motion a clockwork alarum or other mechanical contrivance for the same purpose.

By these means, for instance, any particular degree of expansion desired to be indicated, such as would be caused by the heating of journals or bearings of steam or other engines, can be automatically signalled to the engineer. It can also be made to indicate the presence of fire in buildings.

In the accompanying drawings, Fig. 1 represents a front elevation of the apparatus. Fig. 2 is a front elevation of a connecting rod head of a marine engine, with the apparatus fitted to the upper brass, and in connection with an electric battery and bell attached to the rod.

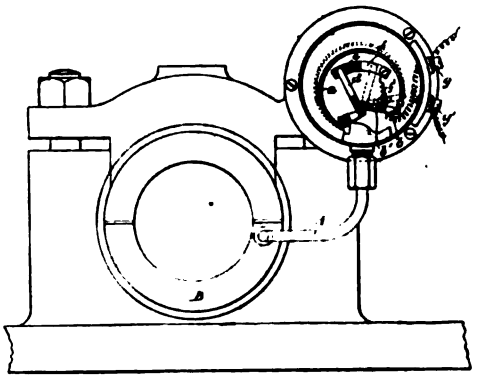

FIG. 1.

The reservoir, A, is filled with gas or liquid having considerable expansive properties under the action of heat, and is connected to the "Bourdon" tube, *a*, the free end of which is attached to the slotted and adjustable lever, *b*, the length of which is regulated by set-screw, b^1. The outer end of lever *b* is attached at any desired point to pivoted contact-maker, *d*, the free end of which is shown in full lines as resting on insulating piece, *e*, which may be of vulcanite or other suitable material. Any heating of bearing, B, would impart heat to reservoir, A, the result being the movement of tube, *a*, with connected levers *b*, *d*, the latter being drawn over on to contact-piece, *f*, as indicated by dotted lines, and the circuit being completed through the terminals *g*, g^1, an electric bell or other alarm will be sounded. It will be obvious with apparatus constructed as described that contact piece, *f*, must not be in electrical communication with both terminals except when lever *d* rests thereon, and to this end the said contact piece is insulated from the metal casing by being screwed into a recess in the face of the insulating block, *e*, a wire, f^1, serving to complete the communication with the terminal *g*, the other terminal, g^1, being, of course, in connection with the casing, the "Bourdon" tube and levers *b*, *d*.

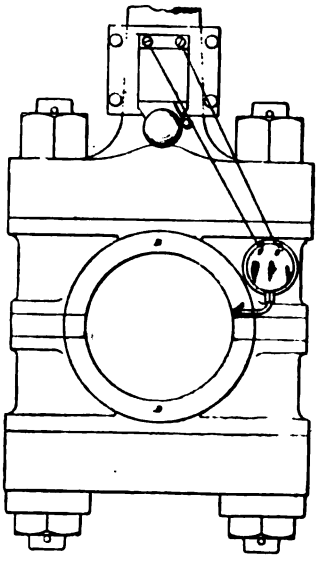

FIG. 2.

It will be also obvious that lever *d* may be used to liberate a spring, setting in motion a clockwork alarum, or other mechanical contrivance for the purpose, if desired.

The apparatus is especially valuable for use on marine engines, as when the connecting rod is in motion it is always difficult to ascertain if the brasses are heating, and is likely also to have extended use in long running machinery for central station lighting.

The use of a "Bourdon" tube in this connection is not absolutely new, but the device of electrical indication of change of temperature, even when slight, automatically in the manner described is the claim of this patent.

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The invention was the outcome of long experiments on shipboard, and it has been applied to one steamer for some time. It practically answers all requirements, and when once fitted does not interfere with the removal of brasses (except to detach wires), and is strong enough to stand a reasonable amount of rough usage, and the parts being made non-corrosive and enclosed in brass box is not affected by water, steam, &c.

As a fire-alarm also it may be fitted to holds of ships, &c., and as the reservoir tube can be made of some length it is useful for purposes that other apparatus is not suitable for.

THE CONSTRUCTION OF DYNAMO-ELECTRIC MACHINES.

BY CECIL P. POOLE.

While there are several valuable works which treat of this subject in an able manner, there seems to be no definite method known whereby proper relative proportions and economical individual proportions may be arbitrarily determined for dynamos or motors. Though it is not practicable to give formulæ which will be absolutely correct in all cases, it seems that some means should be known for obtaining approximately accurate results in the designing of dynamos, and reducing to a minimum the necessary corrections to be made after the machine is tested. It has been the good fortune of the writer to have excellent facilities for experimenting in the matter of dynamo proportions and capacity, and the results of these experiments are herewith presented for what they may be worth. The formulæ here given were obtained from tests with Gramme armatures only, but they may easily be modified to meet the cases of other types of armature.

Proportions.—It is desirable to give the armature core the largest possible cross-section with the smallest possible length, per turn, of conductor. Yet there are cases in which it is preferable to slightly increase the resistance of the armature wire, in order to bring the iron in the armature closer to that of the pole-pieces—that is to say, it may be preferable to make the armature core long and thin in cross-section, so as to diminish in thickness the layers of wire, even though a long, thin core requires more wire per turn for a given cross-section than a square core. No investigations are on record as to the dividing line between advantage and disadvantage as the result of elongating the core of a Gramme armature. The writer has found it a good rule to make the armature core of incandescent light or other low-potential machines square in cross-section up to 15,000 watts output, and to restrict the length to twice the radius of the core in such machines of greater output.

The diameter of the armature cannot be determined by any simple formula which will be correct in all cases; but the following rule of thumb will give very good results ordinarily:—

Make the diameter of the armature core 4 to 6 times the radial thickness of the core, according to the nature of the winding. That is, for very few layers of wire use the smaller multiplier, increasing its value as the layers of wire increase, restricting the value, however, to 6.

The cross-sectional area of an armature core should be neither larger nor smaller than is necessary to accommodate the lines of force emanating from the field-magnet. If the former disproportion exists there will be a waste of iron in the armature; if the latter, a waste of iron in the field; while in either case the amount of copper on both armature and field will be excessive for the output of the machine. As the iron generally used in armatures is of a much finer quality than the best wrought iron ordinarily used for field-magnets the relative cross-sections should be fixed by the ratio between the quality of the iron in the field and that of the armature core.

Taking into consideration the varying quality of iron in the field and the leakage of some of the lines of force created therein, the following formulæ will be found to give good practical results:

For arc light, or other high potential machines, with malleable cast-iron magnet cores:

$$F_s = \frac{4{\cdot}8\ A_a}{f}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and if the magnet cores are wrought iron,

$$F_s = \frac{3\ A_a}{f}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

For incandescent light, or other low-potential machines with cast-iron magnet cores the formula becomes—

$$F_s = \frac{4\ A_a}{f}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and if the cores are of wrought iron,

$$F_s = \frac{2{\cdot}5\ A_a}{f}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

In these formulæ, F_s represents the cross-section of each field-magnet limb in square inches, A_a that of the armature core, and f the number of magnet limbs terminating at each pole-piece.

The pole-pieces should have ample cross-section to allow the passage, without throttling, of the lines of force created by the field-magnets, and to minimise their escape by presenting a path of low resistance, by which they may reach the armature core. It is better to waste iron by having the pole-pieces unnecessarily large than to waste energy by having them too small. At the same time there is no economy in having them embrace so much of the armature circumference that lines of force leap across from pole to pole and do not contribute to the work of inducing electromotive force in the armature wire. From a number of experiments made by the writer it appears that the most advantageous proportion of the armature to be covered by the pole-pieces is ·5 if the armature be wound for high potential, and ·6 for low potential armatures. Hence, for the polar arc in the case of arc light machines,

$$\lambda = \frac{{\cdot}5\ U}{p}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and for incandescent light machines,

$$\lambda = \frac{{\cdot}6\ U}{p}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

λ representing the arc of each pole face, U the circumference of the finished armature, and p the number of poles on the machine.

Care should be taken to make the thickness of the pole-pieces in the direction of the lines of force emanating from the magnet as small as possible, so as to get the field-coils near the armature and to reduce the resistance of the magnetic circuit. The writer had facilities for experimenting with only two thicknesses of pole-piece iron, and only one machine, and consequently is unable to give any accurate data in this connection; but the result of the limited experiments made goes to show the advantage of shortening pole-pieces in the direction of the lines of force. In the experiment referred to, an arc light dynamo of similar build to the well-known Excelsior (Hochhausen) machine, with pole-pieces 3in. thick, gave 6,000 watts. With another frame, similar in all respects to the one first used, save that of the pole-pieces, which were made 1½in. thick, the machine gave 6,200 watts, running at exactly the same speed as in the first case. It is, of course, impossible to make any deductions from a single test, and this test is only mentioned to draw attention to a point that, perchance, may not now enjoy a large share of consideration. The length of the pole-pieces parallel with the armature-shaft is naturally dependent upon the length of the armature, and requires no formula.

The form and proportions of field-magnets vary greatly, and it is not practicable to determine them for all machines alike. The conditions under which a machine works and the nature of the work performed will go far toward determining the form and number of field-magnets to be used. Generally speaking, short, round magnets are the most economical, and as dynamo builders are beginning to use this form to a greater extent, perhaps, than any other, we may infer that it is the most advantageous in more respects than one. In something over a hundred tests made by the writer, it was found that the best results are obtained, as regards intensity of field and economy in wire and energy, when the length of a round magnet limb is 1·5 to 2 times its diameter, and the length of an oval core about the same as its width, if tolerably flat.

Consequent pole machines are most commonly used, for no other reason, apparently, than that someone else makes

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this form, and we follow, like sheep, in their footsteps. For car motors, where light weight is, to a certain extent, a necessity, consequent pole machines are naturally desirable, but under ordinary working conditions, it would seem that dynamos and motors with single magnets are the most economical and to be preferred.

Capacity of Output.—The capacity of an armature may be predetermined by a very simple calculation. It is well known that a wire will generate one absolute unit of E.M.F. for each line of force cut per second, and from this fact, if we assume a given density of lines for the armature core, a rule may be deduced by which the capacity of the armature is quickly and easily determined. Assuming a density of 120,000 C.G.S. lines per square inch in the armature core (Mr. Kapp states that this is a fair average), we find that *each convolution of armature wire will generate ·00004 of a volt for each square inch of core every time it passes a magnet-pole.*

Therefore, the total E.M.F. generated in an armature working at the above-named den·ity will be

$$\text{E.M.F.} = \frac{4\,A_s\,c\,p\,r}{100{,}000};$$

or,
$$\text{E.M.F.} = 4\,A_s\,c\,p\,r\,10^{-5}; \quad . \quad . \quad . \quad (7)$$

where c represents the total number of convolutions of armature wire, r the number of revolutions per minute of the armature, and p the number of poles as before.

As all the convolutions of the armature wire are not in direct series, the result obtained by this formula will have too great a value. In all closed coil Gramme armatures, excepting the Andrews form, the conductor is divided into as many parallel branches as there are poles on the machine, for convenience in commutation. Therefore, the number of convolutions in series will be $\frac{c}{p}$, and the difference of potential at the brushes will be that E.M.F. which is created in $\frac{c}{p}$ convolutions. Hence,

$$\text{E.M.F.} = 4\,A_s\frac{c}{p}\,p\,r\,10^{-5}.$$

But as $\frac{c}{p}\,p$ is equal to c, the factor p is eliminated and the formula becomes

$$\text{E.M.F.} = 4\,A_s\,c\,r\,10^{-5}, \quad . \quad . \quad . \quad . \quad (8)$$

and is applicable to bipolar and multipolar machines alike.

As a density of 120,000 lines per square inch has been assumed for the armature core, the field-magnets will have to be wound so as to supply $A_s p \times 120{,}000$ lines of force in addition to those lines lost by leakage and other causes. A fairly accurate rule for field-winding is as follows:—

Each ampere-winding will impel 2,000 lines of force through a bar of wrought iron one inch long and one inch square in cross-section.

If there were only the resistance of the iron in field and armature to be overcome, the necessary ampere windings would be obtainable by an exceedingly simple equation, but there are two air spaces in every magnetic circuit in a dynamo, and their resistance must be taken into consideration. Allowance must also be made for the lines of force which are lost or wasted. Without going through the deductions by which the formulæ are obtained, it is sufficient to give the following as being tolerably accurate in practice:—The total number of ampere windings on all the magnets of a dynamo, as near as may be calculated before testing the machine, are

$$a\,w = 30\,F_s f p \left(\frac{L}{F_s} + \frac{f u}{2\,A\,p} + \frac{1440\,d}{\lambda\,b}\right), \quad . \quad (9)$$

if the field-magnet cores be wrought iron. For cast-iron cores,

$$a\,w = 20\,F_s f p \left(\frac{1{\cdot}6\,L}{F_s} + \frac{f u}{2\,A_s p} + \frac{1440\,d}{\lambda\,b}\right); \quad . \quad (10)$$

where L = the length of one magnet from pole face to pole face;
u = the mean circumference of the armature core;
d = the distance from the iron of the pole face to that in the armature; and
$\lambda\,b$ = the area of each pole face.*

* In these formulæ Mr. Kapp's estimate of the magnetic resistance of air, 720 times that of wrought iron, is used.

The last four formulæ given, (7), (8), (9), and (10), are based on a density of 120,000 C.G.S. lines per square inch in the armature core, and will, of course, not give good results with any other density; but they may be easily changed so as to be applicable for any other given density.

It is not claimed that they will prove rigorously accurate, and that no corrections will be necessary after testing the dynamo; but the writer has found that a considerable amount of time and trouble may be saved by their use. To make the formulæ applicable for any other given density of lines in the armature core, it is only necessary to alter the coefficient of A_s in (8) and that of F_s in (9) and (10) in the same ratio as the number of lines per square inch in the armature core is altered.—*Electrical Engineer*, New York.

A STUDY OF CERTAIN ERRORS IN THE CONSTANT SHUNT METHOD.*

BY WILLIAM L. PUFFER, S.B.

(Concluded from page 16.)

The largest deflections were always found with the German silver wires, and the least with copper wires with soft-soldered connection. The deflections were seldom twice alike even with the same wires, ranging from 0·0 to 20, being positive at one time and negative at others. The difference between the silver solder and the soft solder was not particularly marked, but seemed to be in favour of the soft solder, both with the copper and German silver leads. These deflections were always smaller and more regular when the shunt was in water than in air. It often happened that the copper soft-soldered leads gave no indications of thermal action, and I never saw any indication of trouble from the double-soldered connection in the middle of the shunt.

This shunt was made to correspond approximately to some of the shunts described in articles on the shunt method of determining currents both in regard to size and length of wire and method of connecting the lead wires.

The thermal action in the standard G. S. shunt was very much greater than in any part or combination of the other shunts, being larger when the copper leads were used by about 7 per cent.; still, even these large thermal E.M.F.'s were quite small when compared to that produced by the calibrating current, and could have been safely neglected if an accuracy of 0·1 per cent. was required. I thought I could now compare this shunt with the standard ohm easily enough; and then with the other shunts by using a current of several amperes, to get so great a difference of potential that the thermal effects would be drowned. I changed the storage battery, letting the current pass through all three shunts, and after a few hours I broke the circuit, and tested the shunts to see whether the current had perceptibly heated them, although a sensitive thermometer showed no change. The copper and large G. S. shunts seemed about as usual, but the standard gave me a deflection of 2,000, which rapidly diminished. This was far too small to be of any effect with this particular shunt, but it was very suggestive. Examination of the shunt showed a slight blackening at the positive end, and a few bubbles of gas; probably due to slight decomposition of water, as the difference of potential had been about 1·8 volts. A reversal of the current caused the blackening to appear at the other end of the shunt, and a slight lessening of the discoloration produced by the previous current.

A current of 22 amperes in all three shunts produced 3·5 volts in the standard, and in breaking 0·00 06 volt at the end of half a minute, which fell to 0·00 000 2 at the end of five minutes. The deflection was in the same direction as when the current was passing, and was reversed by reversing the current. The other shunts gave no such effects even with 60 amperes, so work was chiefly on this shunt. A current of 45 amperes caused an effect which sent the spot off the scale for over a minute.

Curves were plotted, showing the diminution of the thermal effect at equal intervals of time after stopping the main current, which show that while the current is passing, the apparent resistance of the shunt is greatly increased by this action. It appears as if this counter E.M.F. increased with the current, although not quite in the same proportion.

Read at the meeting of the American Academy of Arts and Sciences.

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At this point my experiments had to be postponed, so all apparatus was put aside for a number of months, and then set up in exactly the same manner and position, with the exception that I only used the standard German silver shunt, to which I added three new sets of terminals—two of German silver and one of copper, all soft soldered, using acid for a flux.

Experiments were made to find what caused the variable deflection from this shunt after a current had been passing, and to see if there was any noticeable difference in the materials used in the potential leads and solderings. I designated the different sets of leads in the following manner :—

Leads No. 1 were of German silver, soft-soldered.
" " 2 " copper "
" " 3 " German silver, "
" " 4 " copper, silver "
" " 5 " German silver " "

When the shunt was in air, the effects—due to thermo-electric action arising from the slight differences in temperature in shunt itself previous to the passage of a current—were found to be of such a magnitude as to be negligible in a shunt of so high resistance as this one, although far too great to be permissible in a shunt of a resistance corresponding to those generally used. These thermal E.M.F.'s varied both in sign and amount from zero to 0·00 000 12 volt, and having as an extreme variation about 0·00 000 24 volts. In this respect the German silver leads were anywhere from two to five or more times as bad as the copper, and the too soft-soldered ones seemed to be best, although not enough so to make any marked difference in the readings, which were very small at most. The difference between the copper leads was not appreciable.

With the shunt in air I allowed various known currents to flow for five minutes, and then took several series of readings every quarter or half minute for about five minutes or longer, if necessary, to see what effect was produced in the shunt by the passage of the current. When the currents were only two or three amperes there was no effect produced large enough to notice; and as I could readily detect an E.M.F. greater than 0·00 000 04 volt the action, if any, must have been very small. With currents that produced a perceptible warming of the wire, I found a great variety of effects, differing even in the same set of leads at different times.

Curves were plotted, showing the effect produced by a current of 24·2 amperes in the shunt for five minutes. The sets of wires called No. 1 and No. 3 were made of the same piece of wire, and soldered at the same time with the same solder, and yet they vary in a very peculiar way, for which I have no explanation except that the composition of the German silver shunt has been acted upon by the solder used, and that in the short length (about 2in. near each end), where the soldered joints are, the metal is not homogeneous.

The greatest deflection shows the E.M.F. to have been 0·00 002 volt. Both sets of copper wires act in a similar manner, and give curves which rise quickly during the first half minute, and then gradually drop. Terminals No. 5 give a curve which begins high and falls sharply, and recovers slightly only to fall again. The curves of No. 3 fall rapidly at first, then rise in a regular and very marked manner, after which a fall takes place. Terminals No. 1 do not give especially marked curves unless it be on account of the much smaller deflections than any of the other wires.

I next placed the shunt in water, and examined it the next morning before passing any current through it, and found a large deflection of 105 units, corresponding to 0·00 004 2 volt. There was a slight difference between the various leads, generally about 5 per cent., but all deflections were in the same direction. I was careful to see that all parts of the shunt were under water, and that the soldered junctions were at nearly the same depth, but still the deflections remained. A current of 25 amperes was sent through the shunt to see if there would be a similar action to that when the shunt was in air, but upon connecting the galvanometer the deflection was entirely off the scale for five minutes, and lasted for an hour. I found that a current of less than an ampere in the shunt, but in the opposite direction, would reverse for a while the remains of the effect due to the 25 amperes. There was no apparent difference in the leads, and as the deflections were reversible by reversing the current, and always opposite to those produced directly by the current, I concluded that there was an electrolitic action caused by the current. The positive end of the shunt always turned black, and the negative end tended to become white. I found that by carefully timing duration and direction of currents, I could get a right deflection which would diminish and a left one begin, which would in turn give way to another right deflection, but I was not able to get four changes. With the soldered ends entirely out of water the actions were exactly the same; but the moment the *whole* shunt was out of water all action ceased, and the deflection became very small. Even 10in. of submerged wire gave the deflection, though to a lesser degree, as did also a wet rag wrapped around the wire for a short length.

A current of less than an ampere would produce less than 0·2 volt at the terminals, yet I could get these effects by it, so that simple decomposition of the water was not the cause of the trouble, which it seems to me must be attributed to a "polarization" effect. Having found the cause of the strange deflections when the shunt was in water, I did not continue the experiments any longer. The reason the large German silver shunt did not show such trouble is probably that it had been carefully shellaced when made, and was protected from the oxidising action.

In the light of these experiments, it seemed desirable to plan a shunt and galvanometer for use in comparing currents ranging from 1 to 1,000 amperes, which would not be affected by either thermal E.M.F.'s in its circuit or in the shunt itself. These data were assumed, and the galvanometer calculated.

Calibrating current to be 1 ampere.
Largest current to be 1,000 amperes.
Resistance of shunt to be 0·001 ohm.
E.M.F. at terminals when calibrating 0·001 volt.
Largest observed thermal E.M.F., 0·00 000 8 volt.
Average observed thermal E.M.F., about 0·00 000 08 volt.
Galvanometer current when calibrating to be less than 0·001 ampere.
Galvanometer coils to be 25 ohms of German silver wire.
Deflection to be 10 c.m. at 1·5 metres, or about 2deg.
Earth's field alone to be used.
Required dimensions of galvanometer.

The field due to the coils must be 0·006 in order to produce a deflection of 2deg. where H is 0·1717. The current producing this field would be 0·00 000 4 absolute unit; 25 ohms of No. 18 B. and S. German silver wire would be a length of 8,440 c.m.

$$\text{Then radius of coil} = \sqrt{\frac{8{,}440 \times 0{\cdot}00\ 000\ 4}{0{\cdot}006}} = 2.37 \text{ c.m.}$$

$$\text{Average length of a turn} = 2\pi r = 14{\cdot}9 \text{ c.m.}$$

$$\text{Number of turns} = \frac{l}{14{\cdot}9} = 566 \text{ or } 283 \text{ per spool.}$$

15 × 19 turns give a coil section 0·604 × 0·766in.

The galvanometer was made of a single copper casting, with two channels for the coils, 0·2in. apart. Each channel was 0·77in. deep, 0·61in. wide, and had an inside diameter of an inch. If the galvanometer is much lower than 25 ohms, the variable plug resistance of an ordinary bridge will cause an error too great to be safely neglected when only the galvanometer, leads, and plugs are in circuit. The reasons for the other numerical figures are almost self-evident. The shunt itself I would make of thin sheet German silver, with either copper or German silver end blocks, as was most convenient, but preferring copper. The lead wires to the galvanometer would be of copper, either soft or silver soldered to the end blocks, and should go to a commutator very near the shunt itself, and the galvanometer circuit so arranged as to be easily disconnected from the shunt and placed in a mercury cup to close the circuit for the resistance measurement. I would prefer to measure the total resistance by a standard bridge always connected and kept at a constant temperature.

This kind of a shunt could easily be made so that there would be very little heating, and if shellaced, or protected from oxidation in any other manner, could be used in water, although some kind of oil would probably be better.

There should be suitable mercury cups arranged so that the current could be easily and quickly reversed in the shunt, or the shunt entirely disconnected from the circuit.

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THE PITTSBURG ELECTRIC RAILWAY.

A report has been presented to the Wall-street Ferry Electric Road Company by their consulting and supervising engineer, Mr. Howard Constable, which embodies some points which will be of interest to English engineers. The tramway is worked on the Bentley-Knight system, of which we gave some particulars and illustrations in our issue of February 24.

"The road is about 3¼ miles long. The first four blocks are double-tracked with grades of 3 per cent.; the next five blocks are single-tracked with grades up to 9 per cent., all laid with Johnson rails, dispensing with longitudinal stringers, and cable slot underground conduit. The rest of the road is single-tracked with overhead conductors, and is a succession of heavy curves and grades. There are some 25 curves of 40ft. radius and upwards, and some 36 varying grades, with scarcely any level track. Recently they have discovered that one of the grades is 12½ per cent. This was fortunately provided for by the good luck of having plenty of power.

"Altogether, the roadway presents a most severe test, and the great ease with which the cars take such grades is a most convincing proof of the capacity of electricity for this service, and sets at rest the grade question and many disputed points. The road is built and equipped on the Bentley-Knight system, and a very great deal of credit is due to those having the matter in charge for attempting such a piece of road, and for their perseverance in working it out successfully. Horse traction would be impossible on this line and cable impracticable, owing to the numerous curves.

"The power station is about a quarter of the way out on the road, and is equipped with one engine, four dynamos, and two boilers. The dynamos are coupled tandem, each rated at 250 volts, and would thus give on the line 500 volts. The observations made showed a voltage varying from 465 to 485. (The current at the car was not enough to kill a visiting electrician who laid his hand confidently upon the resistance-box, although it seemed to scare him a little. Possibly he was of that numerous class which Mr. Sprague recently referred to, as so far up in the clouds that no ground contact was made.)

"Natural gas is used under the boilers, and being such a wonderfully efficient and cheap fuel, the actual cost of operation is not a criterion for other places without a very carefully made analysis.

"The cars are equipped with motors on each axle, and the brushes are peculiarly free from sparking. The cars are also lighted by electricity.

"During the afternoon and Sunday traffic the cars ascend these heavy grades with loads varying from 50 to 75 passengers at a speed of 3½ to over four miles per hour. A rack and pinion is used on the heaviest grades, but for the summer the racks have been removed except on the heavy grades on the underground conduit division.

"The clogging up of the conduit has not proved to be a serious matter, and the troublesome switching of the overhead trollies has been done away with.

"There has been the usual long delay and experimenting to bring the work to perfection, but now the directors say they have decided to increase the rolling stock and extend the road over the bridge into Pittsburg. The long delays and expensive experimenting attendant upon adopting electricity on roads, greatly retard the cause of electric traction; but until the electric companies and railway men treat the whole question and the peculiar features of each road in a very different manner, there is little to hope of avoiding this difficulty."

Mr. Constable is an engineer who has had considerable experience with railway as well as with electrical work, and his remarks upon the question of tramway locomotion by means of electricity have a wide bearing. The experience of most electrical engineers up to the present has been gained in electric lighting installations, where the problems superimposed upon the electrical conditions are more nearly akin to those engaging the attention of marine engineers, or of mining engineers, on account of the condition of constant running requisite. In the case of electrical traction, however, it is to the railway engineer we shall have to look for the results of experience, and the cordial co-operation of successful railway men will probably be necessary before electric locomotion arrives at the perfection we all desire. This is not less true of road tramway work than of larger electric railways, and more progress will certainly be made if the preliminary details are put in the hands of those whose previous training enables them to see beforehand and provide against certain contingencies which, to them well known, would have to be bought by dear experience by electric traction experimenters.

LEGAL INTELLIGENCE.

Re GAULARD AND GIBBS' PATENT.

In the High Court of Justice (Chancery Division), before Mr. Justice Kekewich, judgment was given in this action on Monday last.

This was the hearing of a petition presented by Mr. Sebastian Ziani de Ferranti, an electrician, against Messrs. Lucian Gaulard, John Dixon Gibbs, and the National Company for the Distribution of Electricity by Secondary Generators, Limited, praying for the revocation of letters patent No. 4,362 of 1882. The letters patent were granted to Gaulard and Gibbs in respect of "a new system of distributing electricity for the production of light and power," consisting of the employment of an alternating current produced by an electro-dynamo machine, and determining, by its passage through a number of electrical generators of special construction, the formation of induced currents, of which the quality and the value depend only on the construction of the secondary coils of the electrical generators. The specification, as amended, goes on to say that "the currents generated under these conditions are utilised either by lamps to produce light, or by magneto machines to produce motive power." The petitioner described himself as "the patentee of many inventions in connection with the production, distribution and utilisation of electric currents, which inventions are now in extensive practical use," and stated in his petition that among other methods of distribution he for some time past had especially occupied himself with methods of effecting the same "by means of secondary generators by which electrical action is obtained at different points of an electrical circuit by means of electric induction only, without interrupting such circuit or making any connection with the conductor conveying the current." The petitioner also stated that in December, 1885, he invented an improved form of secondary generator for the purpose of effecting, economically and conveniently, the above-mentioned object, and that on December 9, 1885, he obtained provisional protection (No. 15,141 of 1885) for such invention, and had since filed a complete specification. The petitioner also stated that he had since manufactured and used secondary generators constructed according to his invention, the sale of which had recently been interfered with by the respondent company, which "claim to be entitled to restrain any person using any mode of electrical distribution by means of secondary generators, of whatever form or construction such generators may be." The petitioner said the invention patented by Gaulard and Gibbs was in nowise novel, and that the letters patent were invalid on this and other grounds; that the existence of the letters patent claiming a wide and general monopoly of the system of distribution by means of secondary generators which was known to and the property of the public at the date of the letters patent had been and was of great injury to the public by preventing the sale of machines made according to the petitioner's invention, as well as those made by other inventors; and that "the public are prejudiced by the above-mentioned general claim in the said letters patent, because consumers of electricity are not in general acquainted with the science of electricity and the technical application thereof, and are therefore unable to form an opinion as to the invalidity of the said letters patent, whereby the sale and use of improved secondary generators are wholly prevented."

Sir Henry James, Q.C., Mr. Aston, Q.C., Mr. J. C. Graham, and Mr. P. H. Lawrence were for the respondents; and Sir Horace Davey, Q.C., Mr. Moulton, Q.C., and Mr. L. E. Pyke for the petitioner.

Mr. Justice Kekewich, in delivering judgment, after referring, on the question of non-conformity of the complete with the provisional specification, to the observations of Lord Blackburn in "Bailey *v.* Roberton" ("L.R." 3, App. Cas., 1,055), said that the amendment of the complete specification had the effect of substituting the specification in its present form for the original; but in its amended form it must comply with the provisions of the law, including those as to conformity with the provisional specification, as explained in "Bailey *v.* Roberton." The provisional specification in the present case spoke of "an unlimited number of induction coils," whereas the complete specification spoke of "a number" only. Was this an essential difference? His Lordship decided this question in the negative. One passage of the provisional specification was as follows:—"When an electric current approaches or recedes from a circuit of selenoidical form, it determines in this latter a current of induction without in any way modifying the value of the primary current." It had been said that the provisional specification depended on the statement "without in any way modifying the value of the primary current," and that this was false and was abandoned in the complete specification. His Lordship continued as follows:—That it is false is conceded, and for the present purpose it may be assumed that it is abandoned in the complete specification, but I do not think that fact is fatal to the patent. It may be important as regards utility and relevant on the question of novelty, but it does not establish nonconformity between the two documents. The most that can be said is that the provisional specification contains, but the complete one omits, an erroneous statement respecting the patented invention which, if scientifically true, would add greatly to its value. That to my mind is not enough. But it is said that, whereas the provisional specification rests the invention on induction coils of a special construction, the complete specification as amended applies it to induction coils of every character, and this makes the latter different in the sense of being more extensive. This is a formidable objection if true. The foundation of it is the abandonment of the claim for special construction. But the patentee, though he has done this—though he has said, "I do not claim to have any special form of induction coil"—has retained, as part of his combination, the use of those of a special construction. He does not claim to construct, but he requires to use certain instruments, and those only when constructed. What is the effect of this on the complete specification standing alone is another question, but on the question of conformity I hold there is no such difference as is alleged between the two documents. Each asserts the necessity for a

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secondary generator of a special construction. So far, I have dealt with mere questions of language, so as to enable the Court to read the documents for the above purpose. In further examining the specification (and henceforward I deal with the complete one only) one depends much on evidence. There are still questions of construction to be solved, but evidence is required not only to explain terms of art, but to prove what was known at the date of the patent. I may mention here one objection, out of order, to get rid of it. It has been stated by the patentee (Gibbs) that the invention is not thoroughly successful unless there is an equal mass of metal in the primary and secondary wires, and it is urged that, whether true or not—which is said to be immaterial—this ought to have been in the specification. If true, it might, with advantage, have been stated; but it only comes to this—that what is possible with unequal masses, and is more feasible as you approach equality, can only be made a thorough commercial success when that equality is practically attained. I do not think that the omission to make such a statement can defeat the patent. Another objection urged respecting secondary generators was that a divided core is essential, and that this is not stated. It is, without doubt, stated as regards the first, and the evidence has satisfied me that it is sufficiently implied in the language describing the second, and, further, that no electrician would stop to inquire whether a solid or divided core is intended. But, putting aside these two objections to the description of secondary generators, and assuming, of course, the soundness of my view that they are of special construction, how does the specification stand as regards the information given for their selection? And, in order to get an answer to this question, first consider what information is reasonably required? A patentee is bound to tell the public in his specification, not only what his invention is, but how practical effect is to be given to it, and if the invention be a machine, how that machine can be manufactured. I have paraphrased the statute. If there are many different ways of effecting the entire object, or any particular part of it, he is not bound to specify them all in detail, but he is bound to give such instances—selections it may be, from a class—as will enable a competent workman to know what he ought to use. And he is further bound to refer to these instances, or the class from which they come, in language which leaves no doubt what articles are and what are not applicable to the production of the intended result. This is important for two reasons—first, in return for his monopoly, a patentee is bound to put the public in possession, as far as description can do it, of his invention in principle and detail; and, secondly, as a condition of being entitled to restrain other operators from producing his result by the same means, he is bound to tell them precisely what they cannot do except under penalty of an injunction with its serious consequences, and thus to indicate what can be done safely. This is not less true where the patent is for a combination than in any other case. Indeed, I am not sure that the obligation ought not, in such a case, to be particularly strict. If a man says, "I claim to have protected, as my invention, three things combined which, though separately well known, have not been before used together," it is reasonable and right that he should state exactly what each of those three things is; and if anyone of them belongs to a class, comprehending several varieties, then also which of the varieties are intended. And this, of course, he can easily do, as, admittedly, the combined items are well known. What is the combination, several times described, with some variation of language, but none of substance? Take it from Mr. Aston's statement to his own witness Dr. Hopkinson. The combined elements are three in number—(1) an alternating dynamo supplying a main wire; (2) a current in that wire of high tension; (3) a secondary generator such as is described. The description there mentioned is that of the witness, but of course he could only explain or illustrate—he could not go beyond the specification. In passing, let me observe that I am not satisfied that there are really three elements, but I will not dwell on this. Let it be assumed for the present purpose that there are three items, the alternating dynamo, the high tension, and the secondary generators described in the specificaion. There is no difficulty about the first or second, but how has the patentee fulfilled his obligations as regards the third? It is conclusively proved by the petitioners, and not denied by the respondents, that there is nothing special about the secondary generators described, that they differ from others of their class only in unessential details, and that any other instrument of the class—induction coils with divided core—would answer the purpose equally well. So completely is this admitted by the respondents that they contest the conclusion that a special construction is intended. No more about that. Is it reasonable to hold that the divided core is the special construction? I think not. It would, to my mind, be pressing the maxim *ut res valeat* too severely to construe the words "electrical generators of special construction" to mean those belonging to one of two well-known and exhaustive classes, especially when one finds no reference to that class as a whole, but an elaborate description of two particular specimens. If the intention had been to refer to electrical generators having a divided core, that might have been easily done in a single line, and the examples would have been needless and out of place. Then it is urged that the special construction refers to the diminution of tension to those which, receiving an electric current of high tension, pass it on as a current of low tension. It is not pretended that this is said in so many words; no counsel or witness has ventured to put his finger on an expression which states plainly that the secondary generator employed must be of what is styled the "step-down" character. It is conceded that no other will do, and it may be assumed that no other would be attempted by a competent workman, but this is because of a well-known scientific fact, and not because of information given by the patentee. There is no occasion to examine the provisional specification on this point or to inquire whether the complete specification in its original form is agreeable to the view now taken of it as amended. I hold that, as amended, it does not say one of the elements of the combination is a step-down induction coil. That is what you are to use with an alternating dynamo and a high-tension primary wire, in order to produce the desired result. Nothing less than this would suffice. It is not enough to say, as the patentee does, that the quality and value of the induced currents depend on the special construction of the electrical generators without giving a plain statement in what the special construction consists. It is not suggested that the examples are exhaustive of the class of machines which would answer its purpose. I think that a manufacturer is placed by this specification in a difficulty. He knows, of course, that he cannot use either of the induction coils described, but if he wishes to use one of the same class, but differing in detail, he cannot ascertain from the specification whether he may safely do so or not Changing the phrase, the patentee has not in his complete specification ascertained the nature of his invention, and how it is to be performed, in that he has not explained what constitutes the third item in his combination. Mr. Aston says, of course, the use of equivalents would be an infringement, but I do not think that doctrine can be called in aid of a patent which professedly rests on a special construction. In its original form, the specification claimed the special construction of the secondary generators required to produce the desired result. Apart from any question respecting conformity with the provisional specification, the patent could then have been supported, so far as language was concerned; but the patentee was driven to abandon this part of the claim and to amend by way of disclaimer. This was a difficult task. I am disposed to think that it could not have been performed without destroying the patent—could not, that is, have been so performed as to leave a supportable residue. But, whatever was possible, I hold that it has not been done, and that, with the abandonment of the third item of claim, the whole specification falls to the ground. This holding makes it unnecessary to go into the question of anticipation. The evidence on this point is conflicting, and I have the testimony of men of acknowledged eminence and truthfulness on either side. Besides this, there are many documents, and the criticism of them has been long and minute. Before pronouncing a deliberate opinion on the question, I should be obliged again to examine those documents by the light of the evidence, which would have to be reperused for the purpose, and of the arguments, which would have to be recalled and weighed with regard both to documents and evidence. I do not consider myself called upon to do this; but it may be convenient for me to state what, subject to such revision as I have just mentioned, is the result of my best attention during the trial. I do not question—nobody could successfully question—the accuracy of Mr. Aston's distinction between anticipation by documents only—what is sometimes called paper anticipation—and that by manufacture or use. It is grounded on common sense and established by the authorities to which he referred and many others. Guides for the application of the distinction are also to be found in those cases, and notably in the judgment of Lord Westbury, which Mr. Aston quoted. But the distinction concedes that there may be a paper anticipation, and the question here seems to be whether the documents which have been referred to did not separately or together add so much to the stock of common knowledge that nothing remained for invention within the limits of Messrs. Gaulard and Gibbs's specification. Mr. Aston observed that about the years 1878-9 there was an avalanche of patents, and he accepted my suggestion that many inventors were buried in it. He did not pursue the analogy further, and perhaps forgot that a congealed mass has a law of motion of its own, which after a time again brings to light, capable of recognition, though it cannot revivify, buried limbs. So here science has progressed, and in its progress has again called attention to discoveries of bygone years, long buried and forgotten, and of which Sir William Thomson was in 1881 either ignorant or oblivious. Being brought to light, they are recognised as bearing a striking resemblance to others since called into existence, and there is at least some ground for arguing that there is no substantial difference between the past and present. There is often a genuine and complete answer to an argument of that kind. Why, says the patentee of later date, why was not this old invention put in practice if, as you say, it anticipated mine, which has been proved to have been feasible and useful? It is frequently difficult—it is some times impossible—to give a satisfactory reply to such an objection, but I think that Sir William Thomson gave one in this case. He says that at that time, the period of those numerous patents, there was no demand for electric lighting—no encouragement, that is, for inventors to persevere and put their inventions in practice. That would scarcely have sufficed; but he added, in effect, that there was not then known any lamp to which those inventions could be usefully applied, that failing any such lamp they necessarily slumbered, but that, such a lamp having been now discovered, their character and value are apparent. That reply, to my mind, detracts largely from the force of the objection to which I have referred. As at present advised, I fail to see how Messrs. Gaulard and Gibbs made any discovery in the technical sense of the word, or, rather, what they published to the world which was not already disclosed by some one or more of the earlier specifications. As I do not propose to examine any of them in detail, I will not mention more than one, which was not, I think, the one mostly relied on by the petitioner, and possibly is not the best example. I refer to the specification of C. W. Harrison of March 1, 1879. You cannot, it seems, take his description of the third part of his invention any more than you can take any other of the specifications and therefrom build a complete machine according to Messrs. Gaulard and Gibbs' patent—that is, some ingenuity would be required to supplement the directions given. But are not all the necessary directions given? Do they not all concern well-known tools capable of producing well-known effects; and are they not combined precisely as Messrs. Gaulard and Gibbs combine them. Mr. Aston's answer is that the secondary generator was employed to alter the tension, not by diminution, but by increase; not by stepping down—to adopt his favourite expression—but by stepping up. This may be true; but it was common knowledge that an induction coil might be used for alteration in either direction, and the application of it in one way instead of the other cannot be

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deemed invention. Again, Messrs. Gaulard and Gibbs' patent may have taught the electrical world for the first time that high tension in the primary wire is essential to successful work—in other words, that they have discovered that the best, if not the only useful, mode of using the dynamo for electric lighting is by the creation of high tension. If so, they are entitled to credit for having first seen what other labourers in the same field have failed to see, but ascertaining the best use of a known tool does not fall within the proper definition of invention. The reasons which have prompted me to dispose of this case at once on the point on which I have come to a definite conclusion, and not further to consider those requiring further consideration if my judgment were to be rested on them, render it also unnecessary to deal with the question of utility, but on that I have formed a definite opinion, and it is better that I should express it. Having regard to the great and rapid advance made in this particular branch of science during the last few years, one would expect an invention of 1882 to have been ere this improved upon, if not superseded, and it is not surprising, nor is it any discredit to Messrs. Gaulard and Gibb's ingenuity, to hear that arrangements on the parallel system are found to be far more effective than those on the series system adopted by the patentees. The evidence indicated, if it did not prove, that the latter would soon give way, if it has not already given way, to the former. On the other hand, I have sufficient evidence that the series system has been successful—not only tried, but used and found to work with at least a large measure of success. If, therefore, I could hold the patent to be good on other ground, I certainly should not hold it to be bad on the point of utility. For the reasons which I have given I am of opinion that what Messrs. Gaulard and Gibbs describe in their amended specification as their invention, and for which they claim a monopoly, is not the proper subject matter of a patent, that, therefore, the patent granted to them ought to be revoked, and I must make an order for revocation as asked by the petitioner. The respondents must pay the costs, to be taxed on the higher scale.

NEW COMPANIES REGISTERED.

Companies of the Month.—The following electrical companies have been registered during the past month:—

D'Humy Cabinet Battery Syndicate, £250 shares	£15,000
The *Electrician* Printing and Publishing Company, £10 shares	10,000
Buckingham Electric Light and Power Supply, £1 shares	5,000
Electrical Purification Company, £1 shares	15,000
Luther, Hanson and Co., £5 shares	7,500
Petroleum Engine Company of America, £5 shares	150,000
Westminster Electric Light Supply Corporation, £5 shares	100,000
Automatic Electrical Corporation, £20 shares	75,000
International Engineering, £1 shares	5,000
J. and J. Charlesworth, £100 shares	500,000

Westminster Electric Supply Corporation, Limited.—Registered by Linklater and Company, 2, Bond-court, Walbrook. The nominal capital of the Company is £100,000 in shares of £5 each, of which 100 shall be founders' shares, and the remaining 19,900 shall be ordinary shares. Object: to carry on either in the city of Westminster or elsewhere the trade or business of electric lighting. The first subscribers are:—

	Founders' shares.
J. B. Martin, 2, Victoria-mansions, Westminster	1
Sir J. B. Heron-Maxwell, Carlton Club, Pall Mall	1
R. W. Wallace, 2, Harcourt-buildings, Piccadilly	1
J. W. Hiscox, 8, Victoria-street, Westminster	1
W. H. Baker, 74, Vincent-square, S.W.	1
H. Kimber, York-street, Westminster	1
H. A. Hunt, jun., 43, Parliament-street, S.W.	1

The Directors shall not be less than three nor more than seven in number, and the first Directors shall be H. Kimber, Joseph Browne Martin, and Roger William Wallace, and any other persons as the Board shall at any time before the ordinary meeting of the Company in the year 1891 appoint to be Directors, provided that the number of Directors shall not exceed seven in the whole. The remuneration of the Board of Directors shall be £200 per annum to the Chairman of the Board, and £100 per annum to each of the other Directors, and such other sum (if any) as shall be voted by the Company in general meeting.

CITY NOTES.

Removal.—Mr. C. Langdon Davies has removed from 110, Cannon-street, E.C., to Mowbray House, Victoria Embankment, W.C.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ending July 6 amounted to £4,740.

Great Northern Telegraph Company.—The Great Northern Company's telegraph receipts for June were £23,000, making, from January 1 to June 30, £132,000, against £127,120 in 1887, and £124,560 in 1886.

West Coast of America Telegraph Company.—At the last Board meeting the Directors of the West Coast of America Telegraph Company, Limited, declared an interim dividend of 4s. per share, free of income-tax, in respect of the first half of 1888, payable the 23rd inst.

Western Brazilian Telegraph Company.—The traffic receipts of the Western Brazilian Telegraph Company, Limited, for the week ended July 6, after deducting the "fifth" of the gross receipts payable to the London-Platino Brazilian Telegraph Company, Limited, amounted to £3,958.

Direct United States Cable Company.—The Directors of the Direct United States Cable Company, Limited, recommend a final dividend of 2s. per share, tax free, payable on and after the 21st July, making, with the interim dividends already paid, 2 per cent. for the year ending June 30. Recourse will, it is stated, be had to the reserve fund account to make up the required amount for such dividend.

Eastern Telegraph Company.—The Eastern Telegraph Company, Limited, announce that, subject to final audit, the accounts show, after placing about £75,000 to reserve fund, a balance available for dividend sufficient to pay at the general meeting on July 19 next the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum on the preference shares, and a final dividend of 2s. 6d. per share, with a bonus of 2s. per share, free of income-tax, on the ordinary shares, making, with previous payments on account, a total of 6 per cent. per annum on those shares for the year ended March 31, 1888.

Greenwood and Batley, Limited.—The company is formed to acquire the business of Messrs. Greenwood and Batley, engineers and machine-makers, of the Albion Works, Leeds, and to carry on in the United Kingdom and elsewhere the trade or business of mechanical, hydraulic, electrical, and general engineers; machine, engine, and tool makers, iron and brass founders, metal workers, millwrights, boiler-makers, steel converters, colliery owners, metallurgists, manufacturing chemists, shipbuilders and shipowners, and carriers by land or water; and to buy, sell, manufacture, repair, convert, let on hire, and deal in machinery, apparatus for making machinery, rolling stock, steamers, ships, iron, steel, metals, metal implements, tools, utensils, and plant, and conveniences of all kinds.

West African Telegraph Company.—The report of the Directors of the West African Telegraph Company, Limited, for the year ended December 31, 1887, states that the gross receipts, including the balance brought down from last account (£128), amount to £55,268, the general expenditure being £21,586; leaving a balance of £33,682. After providing for debenture interest paid and accrued, £10,000 has been carried to repairs and renewal account, and it has also been considered advisable to write down the preliminary expenses by £500. The Directors propose to carry £3,500 to a debenture redemption account, and recommend the payment of a dividend of 3s. per share, free of income-tax, leaving £1,215 to be carried forward to the current year's account. The Directors are glad to report that since the repair the São Thomé-Loanda section has given no cause for anxiety.

PROVISIONAL PATENTS, 1888.

JUNE 29.

9487. **Improvements in electrical instruments.** Frederick Lawrence Rawson and William White, 11, Queen Victoria-street, London, E.C.

9501. **An improved screw grip for adjustable lamp and other standards, and for electric pendent lamps.** William Arthur Smith Benson, John Lovegrove, and Elie Hinton, trading as W. A. S. Benson and Co., 82, New Bond-street London, W. (Complete specification.)

9503. **Improvements in and relating to steam and other motive-power engines.** John Cole Chapman, 70, Chancery-lane London, W.C.

9504. **Improvements in and relating to steam and other motive-power engines.** John Cole Chapman, 70, Chancery-lane, London, W.C.

9508. **Improvements in and relating to telegraphing apparatus used on board ship.** William France and Robert Morgan, 77, Chancery-lane, London, W.C.

JUNE 30.

9547. **Improvements in electric motors and cars or carriages therefor.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C.

9553. **Improvements in adjustable electrical lighting devices.** Alexander Leslie Fyfe and John Main, 22, Southampton-buildings, Chancery-lane, W.C., Middlesex.

JULY 2.

9584. **Improvements in galvanic batteries for electric lighting and other purposes.** Samuel Miller, 1, Langton Cottages, Melbourne-square, Brixton-road, S.W.

9588. **Improvements connected with electrical appliances for lighting trains, with automatic connection between the carriages.** Friedrich Georg Oberdorfer and Julius Neu, 166, Fleet-street, London.

9595. **Improvements in machinery or apparatus for generating electricity and in electro-motors.** William Henry Allen and Richard Wright, 35, Southampton-buildings, London, W.C.

9615. **Improvement in mounting incandescent electric lamps.** George Henry Rayner, 43, Southampton-buildings, Middlesex. (Julen Ragonet, Paris.)

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JULY 3.

9660. **Improvements in electric motors and dynamo machines.** Alfred Julius Boult, 323, High Holborn, Middlesex. (Orazio Lugo, United States.) (Complete specification.)

9661. **Improvements in telephone transmitters.** Alfred Julius Boult, 323, High Holborn, Middlesex. (Julius Emner, Junior, United States.) (Complete specification.)

9662. **Improvements in or relating to electrical type-writers.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.) (Complete specification.)

9672. **Improvements in dynamo-electric machines and electro-motors.** Grosvenor Porter Lowrey, George Frederick Seward, and Thomas Leopold Willson, 169, Fleet-street, London.

JULY 4.

9693. **Improvements in the manufacture of wire for telegraphic and other purposes.** John Edward Tenison Wood, 40, Grove Hill-road, Camberwell, Surrey.

9708. **The telephonograph.** Gerard Huck, 72, St. James'-street, Burnley, Lancashire.

9730. **An improved cut-out for electric circuits.** William Hopkin Akester and George Hopkins, 57, Chancery-lane, London.

9745. **An improved system for driving moving electric motors or locomotives in series.** Edward Manville, 1, Queen-Victoria-street, London, E.C.

9747. **Improvements in electric bells.** Leslie Watt Winnall, 4, South-street, Finsbury, London.

9759. **A self-acting dynamic machine.** Johann Papiesz, 142, Fleet-street, London.

JULY 5.

9785. **An improved motor.** Isaac Watts and Henry George Gullick, Bristol Bank Buildings, Bristol.

9808. **Electrical fountains.** Joseph Percy Barralet, Sydney-road, Colney Hatch, Middlesex.

COMPLETE SPECIFICATIONS ACCEPTED.

MARCH 26, 1887.

4533. **Improvements in electric locomotives and vehicles.** Michael Radcliffe Ward, 4th Floor, 55, Chancery-lane, London, W.C.

AUGUST 5, 1887.

10,767. **Improvements in instruments for measuring electric currents, and for regulating and controlling dynamo-electric machines and prime movers.** William Lowrie, Charles James Hall, and Harold Werner Kolle, 433, Strand, London.

AUGUST 30, 1887.

11,751. **Improvements in electrical signalling apparatus for railways.** Arthur Edward Nicholl, 54, Fleet-street, London, E.C.

SEPTEMBER 1, 1887.

11,853. **Flexible supports for telegraph or other wires.** Frank Caws, Suffolk House, Lawrence Pountney-hill, E.C.

SEPTEMBER 2, 1887.

11,932. **Improved means for making and insulating the joints or connections of electrical conducting cables.** Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London, W.C. (Siemens and Halske, Germany.)

SEPTEMBER 3, 1887.

11,950. **Improvements in electrical telephones.** John Samuel Ross and Henry Baines, 15, Gunterstone-road, West Kensington, S.W.

SEPTEMBER 5, 1887.

12,025. **Improvements in apparatus for operating or controlling type-writers, type-setting machines and the like by the aid of electricity.** Edward Fitzgerald Law, 45, Southampton-buildings, London.

DECEMBER 1, 1887.

16,554. **A new or improved electric apparatus for indicating distant water level and similar purposes.** Gustav Binter, 18, Buckingham-street, Strand, London.

FEBRUARY 9, 1888.

1968. **Improved secondary battery or accumulator for the storage of electricity.** Walter Tilley, 11, Lewes road, Brighton.

APRIL 17, 1888.

5731. **Improvements in and relating to apparatus for measuring electric currents, which apparatus will also serve as a motor.** Henry Harris Lake, 45, Southampton-buildings, London. (Elihu Thomson, United States.)

5732. **Improvements in and relating to apparatus for measuring electric currents, which apparatus will also serve as a motor.** Henry Harris Lake, 45, Southampton-buildings, London. (Elihu Thomson, United States.)

APRIL 25, 1888.

6157. **Improvements in lanterns for electric arc lamps, and in posts or columns for supporting the same.** Richard Edwd. Keen, 45, Southampton-buildings, London, W.C.

MAY 22, 1888.

7541. **Improvements in dynamo electric generators or motors.** William Phillips Thompson, 6, Lord-street, Liverpool. (Henry W. Spang, United States.)

7551. **Improvements in coupling devices for electrical and other purposes, and in indicators to be used in conjunction therewith.** John Kendall and Owen Cooper, 45, Southampton-buildings, London, W.C.

MAY 29, 1888.

7850. **Improvements in or relating to alternate current electric distribution.** William Phillips Thompson, 6, Lord-street, Liverpool. (George Westinghouse, Junior, United States.)

MAY 31, 1888.

7977. **Improvements in the mode of filling secondary battery plates.** Henry Gurney Morris and Pedro Grotjan Salom, 320, High Holborn, London, W.C.

JUNE 5, 1888.

8171. **Improvements in magneto-electric liquid level indicators.** John Joseph Ghegan, 52, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1887.

8701. **Producing electric energy for lighting, &c.** J. Ross. 8d.

10,701. **Electric incandescence lamps.** W. B. Sayers and W. H. Sturge. 8d.

10,740. **Regulators for electric lamps.** S. Mathis. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday.
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	2¾
12 Feb.	2/0	— fully paid	5	3¾
26 April	1%	Anglo-American	100	41¼
26 April	2%	— Pref.	100	60½
12 Feb., 85	5/0	— Def.	100	14
28 June	3/0	Brazilian Submarine	10	12½
14 June	1/0	Con Telephone & Main	1	¾x
15 Feb.	8/0	Cuba	10	13½
28 July	10/0	— 10% Pref.	10	19½
28 Mar.	2/2½	Direct Spanish	9	3¾
28 Mar.	5/0	— 10% Pref.	10	9
28 Mar.	2/0	Direct United States	20	8⅝
12 April	2/6	Eastern	10	12
12 April	3/0	— 6% Pref.	10	15
1 Feb.	5%	— 5%, 1899	100	111
26 April	4%	— 4% Deb. Stock	100	108
26 April	5/6	Eastern Extension, Australasia & China	10	12¾
1 Feb.	6%	— 6% Deb., 1891	100	106
2 July	5%	— 5% Deb., 1900	100	103½
2 May	5%	— — 1890	100	103
2 July	5%	Eastern & S. African, 1900	100	106
28 Mar.	8/3	German Union	10	6⅛x
12 April	2/0	Globe Telegraph Trust	10	5¾
12 April	3/0	— 6% Pref.	10	13⅞
30 April	5/0	Great Northern	10	14¼
1 Mar.	5%	Gt. Northern 5% Deb., '83.	100	108
29 Feb.	10/0	India Rubber, G. P. & Tel.	10	17½
11 May	37/6	Indo-European	25	38
30 May	3/0	London Platino-Brazilian	10	6¼
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	⅝
26 April	4/0	Reuter's	8	8
		Swan United	3½	2⅜
15 Feb.	15½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
29 Feb.	36/0	Telegraph Construction	12	40
3 Jan.	6/0	— 6%, 1889	100	105
30 Nov.	5/0	United Telephone	5	13¾
		West African	10	5¼
1 Mar.	5%	— 5% Debs.	100	95
29 Dec.	6/0	West Coast of America	10	7
30 June	8%	— 8% Debs.	100	117
11 May	9/	Western and Brazilian	15	10
11 May	6/10½	— Preferred	7½	6½
11 May	2/1½	— Deferred	7½	4
1 Feb.	6%	— 6% A	100	112
1 Feb.	6%	— 6% B	100	107¼
		West India and Panama	10	1
30 May	10/0	— 6% 1st Pref.	10	10⅞
13 May, '80		— 6% 2nd Pref.	10	7½
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	103

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NOTES.

Pekin.—The Emperor of China is having electric lights fixed up in his palace grounds at Pekin at a cost of £1,400.

Parliamentary.—In the House of Lords, on Monday, the Electric Lighting Order Confirmation Bill was read a second time.

Telegraphs to Australia.—We are informed by the Post Office authorities that telegraphic communication with Australia and beyond is now restored.

The New Filament.—The wonderful filament submitted to Mr. Westinghouse, invented by a Russian, we are given to understand was that of the Khotinsky lamp.

Eiffel Tower.—It was proposed to work one of the lifts at the Eiffel Tower in Paris by an electro-motor, but we understand that for some reason the idea has been abandoned.

Electric Tramway for Milan.—The Omnibus Company of Milan have appointed a commission to go into the prospect of establishing an electric tramway between Milan and Monza.

Bootle (Lancs.).—At a meeting of the Bootle Town Council, on Wednesday, it was agreed to sign a memorial to the Postmaster of Liverpool, asking for increased telegraphic accommodation.

Electric Lighting in Paris.—The larger portion of the work of fitting the Salles des Fêtes of the Hotel de Ville, at Paris, with electric lights has been carried out, and gas will soon be completely ousted.

Julien Company.—The announcement is made that the Julien Electric Company have declared a semi-annual dividend of 2½ per cent. This is taken as a sign of the growing demand for storage batteries in America.

Bothers the Astronomers.—The arc lights at Detroit are so often reflected on the clouds, causing an effect like that of the moon, that they interfere with astronomical observations, and the astronomers have to wait very late until they are put out.

Sunday Telephone.—On Sunday last the telephone was working for the first time in London on the Sabbath. It will now continue to be available night and day for all subscribers who require to use it. It will be available when the telephone offices are closed.

What the Natchez (U.S.) Gas Company Says.—In their report the directors say: "This company, instead of enlarging ther gas plant to meet any growing demand for nocturnal uses, wisely propose to enlarge the scope of their work by adding an electric light plant."

The Lightning Gave the Alarm.—On Sunday night the Metropolitan Fire Brigade turned out in the fierce and pouring wet in answer to the fire alarm. It was found eventually, however, that it was merely a freak of the lightning, the alarm being probably given by inductive effect.

London Bridge.—The plant for central-station lighting at London Bridge, mentioned last week as being started by Messrs. Beaumont and Kent, is being installed for Mr. John Kent, A.M.S.T.E., principal of the College of Electrical Engineering, Railway-approach, for whom Mr. F. J. Beaumont is engineer.

The Pilsen-Joel Company.—As will be seen in our advertisement columns, the Pilsen-Joel Company invite tenders from capitalists or companies to take over the whole of their patents, together with the works of the company, as a going concern, and their central lighting stations, which are capable of large extension.

Electric Execution.—"Electranged" is the title given in New York to the method of execution by electricity. It is thought doubtful, after all, whether it will be adopted. The result of the experiment has caused a reaction against it. Edison, it is said, by the way, recommends that the criminal be handcuffed and electric wire fastened to the handcuffs.

Personal.—We must congratulate Messrs. Woodhouse and Rawson, Limited, on having obtained the services of Mr. Antony Reckenzaun as manager of their works at Cadby Hall. Mr. Reckenzaun has also been appointed as managing engineer to a company which Messrs. Woodhouse and Rawson, Limited, are forming for the application of electricity to locomotion and transmission of power.

Quick Work.—The Heisler system has been adopted at Hackettstown, N.J., for street and commercial lighting, and a plant has been erected by Messrs. White and Rusling, agents for the company, of 137, Broadway, N.Y. The contract was signed and the order sent for the electrical appliances on May 1, and the apparatus was tested and the lights turned on for the first time on June 2, which is putting up a plant on pretty short notice.

Hell Gate Tower Sold for Scrap.—The Hell Gate electric tower has just been sold for 125dols. It is only a little more than two years ago that the tower was erected at a cost of 14,500dols., but the light proved a failure. It was found that it threw shadows across the surface of the water, which made navigation dangerous. The mariners petitioned the Government to extinguish the light, which the Government did at midnight 1st December, 1887.

Medical Electricity.—The Directors of the Institute of Medical Electricity, Limited, have taken commodious premises at 24a, Regent-street, with side entrance in Jermyn-street, and are having them fitted with the latest and best appliances for electrical treatment by all known methods, including the "Electrified Room" system, which has been approved so highly by medical men at Southsea. It is expected that the establishment will be opened in a few weeks.

Strand.—Last week at the meeting of the Strand District Board of Works, the following notices of intended application for provisional orders to supply electricity for lighting were reported as received—viz.: from the South Metropolitan Electric Supply Company, the Electrical Power Storage Company, London Electric Supply Corporation, the Westminster Electric Supply Corporation, and Messrs. Walter F. Glover and Co. These were referred to the Lighting Committee for consideration and report.

Strange Recovery of Eyesight.—A Wolverhampton paper states that during the heavy thunderstorm of Tuesday a collier, named Bates, who had lost his sight through an accident, was being led home, when a flash of lightning was reflected on the spectacles he was wearing to conceal his disfigurement. After the peal of thunder which followed he complained of pain in his head. The next moment, to his surprise, he found that he had regained possession of his eyesight. The occurrence has caused considerable excitement in the locality.

Bournemouth.—At the last meeting of the Lighting Committee of the Town Council a letter was read from Mr.

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Sidney Morse, enclosing a notice of intention to apply for a provisional order under the Electric Lighting Act, 1882, to authorise Messrs. Walter T. Glover and Co., or a company to be formed for the purpose, to supply electricity within the area of the Urban Sanitary Authority of Bournemouth. A letter was also read from the secretary of the Bournemouth Electric Light and Power Co., setting forth the objects of that company. It was decided merely to acknowledge the letters.

Ornithological.—Two sparrows have hatched a brood of young ones under the dome of the electric bell at Hook Station, on the main line of the L. and S. W. R. As this bell gives warning of the approach of all passenger trains, whether they set down at Hook or run through, it is rung very frequently during the day, and one would hardly have supposed when the birds found that they had selected this curious and somewhat noisy nesting place, that they would persevere in their intentions. The nest occupies the space between the top of the box containing the electro-magnets and the dome.

Italian Exhibition.—With reference to our article last week, Messrs. Laing, Wharton, and Down write pointing out that the installation at Peter Robinson's, consisting of 80 arcs and 400 incandescents (even when increased to 700, and with accumulators for 100 thrown in) can hardly be considered "nearly equal" to that at the Italian Exhibition, where they are running 315 10 ampere arcs, and 300 incandescents. They also indicate that the remark that when arc lamps are run in series not more than four or five lamps can conveniently be turned off from the circuit does not apply to the Thomson-Houston system.

Uses for Motors.—On the Comstock, in America, the new Nevada Mills will be run with electric motors, through a five-eighth copper cable, driving 60 stamps. For Silver City, Idaho, a Sprague electric plant is used at a mine to drive a 50 stamp mill four miles away from a waterfall, and the same manufacturers have recently received an order for an electric plant to be used in training and elevating the guns on the new United States cruiser "Chicago." We hear also of an iron company in the South thinking of running dynamos by means of waste heat at the furnace to drive pumps several miles away.

Sweden.—Electric lighting has been successfully tried on the Skane-Holland Railway, in Sweden, where a train was despatched from Helsingborg, fitted with electric light in all the carriages except one, so as to demonstrate its superiority. There were altogether 17 incandescent lamps in use, fed from an accumulator in the luggage van. The light was very good and steady, and all the lamps could be lighted or extinguished in a moment. The installation has been effected by Messrs. Edwin Audrén and Co., Gothenburg, and it is the intention to fit all the express trains between Christiania and Helsingborg with the electric light.

Electric Light from the Tide.—It is proposed to light the rising watering place of Sullivan Harbour, Maine, U.S., by means of electricity by utilising the tide. Both arc and incandescent lamps will be required, and it is proposed to utilise the currents, which run for four hours either way on each tide through a narrow gorge within fifteen hundred feet of the village street. Its tide waters fill an immense arm of the sea, which runs up for three or four miles behind the village, and thousands of horse-power goes to waste, which it is now proposed to use, and by means of dynamos run by water wheels, and auxiliary storage batteries, light up the district.

Richmond.—At the Vestry meeting on July 4, the vestry clerk read a letter from the West Middlesex Electric Lighting Company, Limited, Caxton House, The Grove, Hammersmith, W., giving notice that it is the intention of the company to apply, on or before the 21st December next, to the Board of Trade for a Provisional Order authorising them to supply electricity for public and private lighting and other purposes within the area of the Board. It was suggested that the letter should be referred to the General Purposes Committee, as there were not so many directors of the gas company on that; but it was finally referred to the Parliamentary Committee, as being composed of gentlemen who thoroughly understood the meaning of intended Bills.

Public Supply at Bradford.—With reference to the circular recently issued by the Bradford Corporation, particulars of which we gave last week, we may point out, with regard to the alternative method of lighting, that experience has shown that for restaurants, cellars, and offices below surface, and in other positions where gas is almost constantly used, the charge of £1 (or even of £2) each lamp per year often offers a very great saving over gas burnt continually; whereas those customers who usually light up at dusk and close at six naturally object to pay an equal sum to the long-hour consumer. To them the meter rate of 5d. a unit will be little, if any, increase on the gas bills. If the Corporation can keep up these two alternative methods of charging there will result a great impetus in the extension of electric lighting in that neighbourhood.

They Just Live on the Cars.—"Every little town in Southern California is just ring-streaked and striped with street car lines. Street cars and cement sidewalks—the nicest sidewalks in the world—why, they lay them away out into the country. A town of 2,500 people out here without street cars, electric lights and suburbs would be as great a rarity as a leopard or a coach dog without spots. There is an electric motor car in San Diego running out to University Heights. Coming into the city down the long hills—talk about speed. You just hold your breath and try to think of the prayer you should have said when you got out of bed. A runaway horse on a thirty day note couldn't keep in sight of one of those cars coming down the grade. One thing, rents are so fearfully high, and houses are so hard to get out here, that I suppose a good many people just about live in the street cars, and that makes the lines pay. They do seem to pay, and on five cent fare, too".—*Burdette.*

Electric Firing.—Since safe explosives and water-shields have come into use, says Mr. Geo. S. André, F.G.S., in the *Colliery Guardian*, electric firing has assumed a degree of importance it had not before. Electric ignition has become a necessity. Hitherto the machines employed for generating the electric current, or the electric discharge by means of which the fuses are ignited, have failed to satisfy all the conditions of underground blasting. Frictional machines are uncertain, and the magneto-exploders in common use leave much to be desired. A French electrician of repute, M. Ducretet, has devised a machine for firing purposes on the lines of the well-known Breguet exploder, which promises to satisfy every condition. It is simple, light, well protected, and very effective where the number of shots to be fired simultaneously is not large. By an ingenious arrangement it is made to register the intensity of the spark, and also to pass a testing current through the fuses without risk of ignition.

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Electrical Treatment of Sewage.—At the annual meeting of the Association of Municipal and Sanitary Engineers, held at the Institution of Civil Engineers, Westminster, last Friday, Mr. William Webster, F.C.S., read a paper describing the decomposition and purification of sewage by means of electricity. He passed a strong current of electricity through sewage before the meeting, and the solid matter speedily rose to the surface, leaving the fluid apparently bright. He also exhibited a sample of effluent water eight months old, and a specimen of a disinfecting fluid obtained from sewage 12 months ago. The chief expense, he stated, was the engine power, and the process, could be applied to any existing tanks. The thanks of the association were voted to Mr. Webster for bringing before it so important a matter before he had made known his process in any other way. Several speakers considered the process likely to be productive of great results, provided it could be economically applied to the treatment of large quantities of sewage, as the analyses submitted showed the effluent water to be absolutely free from suspended matter.

Provisional Orders.—The Board of Trade report for the past year upon their proceedings under the Electric Lighting Act has been issued, according to which the only application for a provisional order since the last report was that of the South Metropolitan Electric Supply Company, for permission to occupy the City and a select district of the West End of London. After hearing the objections of several of the local authorities named in the application, the Board of Trade granted an order restricted to the parishes of St. James, Westminster, and St. Martin-in-the-Fields, with Waterloo Bridge and a small portion of the Victoria Embankment. It may be remarked here that a Bill to confirm the order was introduced into the House of Lords, and read a first time last week; the standing orders having been suspended for this purpose. Five applications for licenses are recorded, of which only one, relating to Liverpool, has been granted besides the license to the Kensington Court Electric Lighting Company, which was mentioned in the last report. It is probable that the next report of the Board of Trade upon this subject will contain more matter.

Bath.—In a letter accompanying Mr. Massingham's tender for the lighting of Bath, he states that the tender is based upon an estimate to pay only 5 per cent. per annum upon the capital employed, provided everything is conducted upon the most economical scale. He believes it is the lowest tender that has ever been made for public electric lighting, and if accepted a local company can at once be formed for supplying the light permanently for private as well as public use, so that the bathing establishments and other places can at any time be lighted. The seventy-one arc lamps provided for being placed principally at the junction of streets will displace 315 gas lamps, which, reckoned at £3. 0s. 8d. each, make £955. 10s. They also displace eighteen large lamps, twelve of which, considered as costing £10. 3s. 1d. each, make £171. 16s. 6d., a total of £1,127. 6s. 6d. The total cost of the seventy-one arc lamps, reckoning them at £18. 17s. 6d. each, is £1,330. 2s. 6d. This is a lower price than the council was led to expect, the sum first named being 50 per cent. more than gas, whereas the estimate is only 20 per cent. more, though giving several hundred per cent. more light.

Sprague System at Wilmington.—The President of the Wilmington City (Delaware) Railway Company says, concerning the overhead (Sprague) electrical system in use on the Riverview extension: "The system has been in operation here for three months, and from a practical experience during that time we can pronounce it a complete success. In comparison with horse-power we find it decidedly cheaper and more efficient in every way. It is popular with our patrons on account of its cleanliness, its smooth and rapid motion, and especially for the absence of the usually overtasked and labouring horse. Our road is quite hilly, and the cars, loaded sometimes with seventy passengers, climb with ease, at the rate of five miles an hour, a 5½ per cent. grade having a 90ft. curve. The cars are 16ft. long, and each has been running continuously from the start 16 hours a day, making 64 miles daily on the 1 1-3 miles of our extension. At first many persons here were sceptical about the successful use of electricity as a motive power instead of horses, but the practical demonstration made on our line has converted them, and directors, press, and public have only words of praise for electricity, and endorse it as the future motive power for street car traffic."

Bristol Cathedral Lighting.—The following testimonial has been received by Mr. H. G. Massingham with respect to the recent lighting of the Bristol Cathedral, the first in the world to be lighted throughout with electric arc lamps. Messrs. Newall and Co., who have had great experience in electrical work, more especially ship lighting, were first asked to undertake it, but declined the responsibility of what they regarded as an experiment. Mr. Massingham was at their suggestion, communicated with, and agreed to take all responsibility for the electrical portion, Messrs. Newall and Co. supplying the engineering plant used. The lighting proved an unqualified success. The thanks of the committee were embodied in the following letter: "At a committee meeting, held at Mr. Risely's a few day since, it was unanimously resolved: 'That the best thanks of this committee be tendered to Messrs. Massingham, electrician, and Newall, engineer, for the highly successful and intelligent manner in which the electrical lighting of the cathedral was carried out on the occasion of the above services, for their generous aid when contracting for the same, and for the courteous way in which all the wishes of the committee received attention.' Need we say that we are afforded much pleasure in sending the above, and, at the same time, would send our personal thanks for your readiness to meet us in every way. (Signed) H. Swayne, Herbert Riseley."

The Mauritius.—Sir E. Watkin, a few days ago in the House of Commons, asked the Under-Secretary for the Colonies whether the island of Mauritius, which had a naval dockyard, and the fortified harbour of St. Louis was, like Bermuda, unconnected by submarine telegraphic cable independent of foreign interference, with any other portion of the empire; whether the Malagassy Government so long as three months ago expressed their readiness to assist in establishing direct communication through their territory with Great Britain by means of a cable from Mozambique, to be landed at Mojunga, and by the erection of a land line thence to the capital, and onwards to the east coast at Andevoranto, or Vatomandry, with the right to connect the same by cable to Mauritius, and whether he had come to any decision in the matter?—Sir J. Gorst, for Baron H. de Worms, in reply, said there is no direct communication with Mauritius, but messages are sent as opportunity offers by steam vessels from Aden, Natal and Australia. The particular proposal referred to has not come under the consideration of Her Majesty's Govern-

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ment, but various schemes for laying a cable to Mauritius *viâ* Madagascar have been and still are under consideration. It has not, however, been found possible to make provision for this service, and until arrangements can be made for meeting the cost of a cable, it is not possible to come to a decision as to the particular route.

Laboratory Testing Stand.—A simple and cheap stand for holding laboratory testing apparatus, one that can be modified in any desired direction, is a great desideratum both for private experimental use and for technical classes. Such a piece of apparatus, largely in use in Germany, but little known in England, is described in *The Engineer* for June 22, the device of Dr. Edelmann, who is the author of several works on new apparatus published in Stuttgart. The apparatus consists of some forty parts, which can be mounted in various combinations upon a tripod stand. It includes, among other appliances, two cylinders of vulcanite for electrical insulation purposes, several thin brass rods tapped at each end, five cross carriers, three cross carriers with narrower boring, two hooks with clamps, clamping screws for electrical connections, clamps for holding paper or other thick films, clamps for holding thin films, four nickel-plated balls for use as electrodes, a disc and two points, pincers, insulated handles, a carrier for vacuum tubes, a delicate screw regulator, and so on. The combination of the stand can be used in all manner of complicated laboratory tests, and the borings are made so as to fit the gauges of rods—whether glass, vulcanite, brass or iron—most commonly in the market. The apparatus is in no way protected by patent, Dr. Edelmann wishing it to be considered the common property of men of science. The apparatus has been imported by Mr. Heinrich Trinks, of Primrose Hill.

Creosoted Underground Mains.—The treatment of timber with dead oil of coal tar, commonly termed "creosoting," was introduced in 1838; and timber treated at that time is as sound to-day as then. This method of laying wood underground has been often advocated and has been very largely employed in America for electric conductors. The Eppinger and Russell creosoting works have supplied large amounts to the telephone companies in Brooklyn, Boston, Chicago, and other towns, and to the Edison Electric Light Company of New York, Boston, Columbus, and other towns. The system used by them is termed the Macdonald conduit, and is made in 16-ft. lengths of creosoted timber, cut in sections with a series of semi-circular grooves top and bottom, so that sets of wires can be laid therein. When properly laid it is perfectly watertight and makes a solid block; it can be altered, increased as desired, or wires can be taken out with ease. It is cheap, and easy to lay, and is very durable. The method for laying underground wires in creosoted wood is greatly extending in Philadelphia. Mr. Wyckoff has recently built creosoting works in connection with his wooden pipe factory, and has obtained a contract from the Bell Telephone Company, of Philadelphia, to furnish them his wooden casing for underground wires; they will put several pipes in the same trench from 12 to 70, and it will take millions of feet for the city of Philadelphia. Mr. Wyckoff is also furnishing casing for the subways of New York City, all of which will be creosoted.

Tenders for Lighting Bath.—The report of the Electric Lighting Committee has been issued, giving particulars of the seven tenders received in answer to the advertisement for the lighting by electricity of the streets in the district approved by the Council. The report states: "All the persons tendering concur in recommending the adoption of overhead in preference to underground wires, as being much less expensive, and less liable to failure on account of defective insulation. There are three methods of fixing overhead wires: (1) on poles placed on house roofs, (2) on brackets placed on house fronts, (3) on lamp posts in a line with the kerbstone placed from 100 to 150 feet apart. The last-mentioned is the method recommended." The following are the chief particulars of the different tenders: Mr. H. G. Massingham, Thomson-Houston system, 70 lamps of 1,200 c.p. each, price per lamp on three year's contract, overhead wires £19. 17s. 6d., underground £25. 17s. 6d.; Anglo-American Brush Electric Corporation, 67 lamps of 2,000 c.p., J. Ravennes, London, Brush system, 40 lamps of 1,250 c.p, overhead £26, underground £30; Messrs. C. Allen and Son, Taunton, Brockie-Pell or Pilsen-Joel system, 66 lamps, 1,000 c.p., overhead £21, underground £25, or same firm Thomson-Houston system, 66 lamps, 1,200 c.p., overhead £25, underground £29. 10s.; Messrs. Nicholson and Jennings, London, Brush system, 43 lamps, 2,000 c.p. (overhead only), £30. 8s. 4d.; Messrs. Newall and Co., Bristol, Brush system, 68 lamps, 2,000 c.p. (overhead), £27, underground £31, or Thomson-Houston system, 68 lamps, 1,200 c.p., overhead £25, underground £29; Messrs. Laing, Wharton and Down, London, Thomson-Houston system, 75 lamps, 1,200 c.p., overhead £24, underground £28. The committee have fully discussed the several tenders, and they are of opinion that the one sent in by Mr. Massingham presents great advantages, and that the small extension of the area to be lighted with electric light which it suggests (a plan of which can be seen at the town clerk's office) is well worthy the consideration of the Council.

The "Sun" Miners' Electric Lamp. — Among the electric miners' safety lamps exhibited on the occasion of the reading of Sir Frederick Abel's paper on mine accidents in November, 1877, before the Institution of Civil Engineers, was the "Sun" lamp, which met with commendation from Sir Frederick Abel. This lamp was described shortly afterwards, at which time it had been tested by Mr. C. E. Rhodes, who pronounced it to be fully entitled to rank as a miners' "safety" lamp. He, however, suggested some detail improvements which promised to increase the working utility of the lamp, and these improvements have since been introduced into it, and it has now been successfully tested in practical use in two collieries. In the battery of this lamp the positive element is zinc, the negative element being a plate of special metallic alloy. The weight of each negative element is 6oz., and that of each positive element 3oz., the total weight of the elements being 1lb. 2oz., and the total weight of the lamp 4lb. 6oz. The elements are suspended in a depolarising solution of dilute sulphuric acid, and there is no waste going on while the lamp is not running, although the elements remain suspended in the solution. The battery can be used as a primary, but is at its best as a secondary battery, charged from a dynamo in the usual way. The light is emitted from a glow-lamp of 1½ c.p. nominal, the lamp being protected by a toughened glass cover, and should this be broken the light is instantly extinguished automatically, whether or not the glass of the glow-lamp itself be broken, thus giving absolute safety against risk of explosion. The battery is encased in wood and metal, and the lamp is 8in. high by 4in. diameter. The average electromotive force during a period of ten

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hours is 3·8 volts, the current through the lamp varying from 0·6 to 0·25 ampere, according to the lamp used. The ordinary run of the lamp is ten hours, but Mr. I. Knowles, of the Pearson and Knowles Coal and Iron Company, having used it in his collieries, reports that it will run for twelve hours, and he states that he considers it suitable in every respect. The New Portable Electric Lamp and Power Syndicate Company, of 43, Coleman-street, London, have also received a highly satisfactory report from the Wigan Coal and Iron Company, who have also used it in their collieries.

Electric Lighting of Tram-Cars in Bradford.—The lighting of tramcars and omnibuses by primary batteries seems to be a favourite occupation of inventors. There is nothing impossible about the idea, the main item being simply and solely the question of expense. We remember to have seen several omnibuses lighted (with a great *eclat*) by "Eclipse" batteries. Nothing more seems to have come of the experiment. This week we notice in the Bradford papers enthusiastic reports of a new (?) invention by M. Charles Gauzentes, a Belgian electrical engineer, which is being tried by the Bradford Tramways and Omnibus Company. The account has this, in common with all primary battery reports, that big claims are made, and no details of cost are given. "The system is the first that has been successfully applied to the lighting of tramcars, and it is the only one of its class in the market. The idea of lighting by batteries is not new; but it has hitherto been unsuccessful in application, by reason of the cost and the unsatisfactory method of manufacture and the fitting of the apparatus. The whole system of lighting," the report goes on to say, "has been carefully revised by M. Gauzentes, and so adapted by him to the illumination of cars that it is practically a new invention." The only details of this new invention given are that it is placed under the seat, that it consists of 12 cells, is charged with a "special liquor," and runs an eight-candle lamp. Now, there is nothing new in all this; we have had patent primary batteries with 12 cells, and eight-c.p. lamps, and special liquors, by the score, worked by enthusiastic inventors, which have always eventually come to grief over the item of cost, and never a one has been made to pay. Far be it from us to discourage any attempt to light 'buses and cars by primary batteries if anyone can prove its economy, or will contract to run it themselves; but we fear the taking advantage of unsuspecting and credulous investors who see an 8 c.p. lamp run with a battery, and who do not realise that electricity by means even of a dynamo and steam-engine (the most economical method) is not yet as cheap as gas or oil, and with zinc—which is some twenty times the price of coal—except as a fad or an experiment, is totally out of the question as regards cost. The experiment continues for three weeks. If the inventor has anything to justify him in raising the hopes of the tramcar directors, or is intending to ask for money, we hope he will give full particulars where there is a fair chance of discussing them, before inducing expenditure which may probably go the way of the score or so of previous primary battery investments.

Incandescent Street Lighting.—Councillor Crowther Davies has been writing to the *Birmingham Daily Post*, stating that he shall shortly renew his resolution to put an end to the contract for supply of electric light at Leamington. Though personally believing that the company has endeavoured to carry out the contract to the best of their ability, he strongly believes (while disclaiming all interest, direct or indirect, in the gas or other lighting company), that the incandescent light, as a street light, is an "experimental failure." The company has had "more time" granted it, but the borough has not had more light. He maintains, in a further letter, that the application of a test will not help matters, and that the contract which stipulated for a certain notice to terminate the agreement leaves the Council quite at liberty to act in accordance therewith, and to make future arrangements for another and a better light, and Mr. Davies says he is satisfied that he has the ratepayers with him in the course he is pursuing. The trouble at Leamington, even if finally made satisfactory, is unfortunate, falling as it does at the time when many other towns are practically considering the question of their own lighting, but its best effect may be in acting as a deterrent to authorities attempting to do in a small way what should only be done, if done at all, in a manner that will prove sufficient for the purposes intended. Whatever may be said as to the present sufficiency of the light at Leamington, and upon the relative advantages of arc over incandescent lighting for streets and public places, it is certainly far from absolutely true that incandescent lighting for streets is nothing but an experimental failure. We are perfectly aware that for many situations of this kind the arc light has, especially in America, a very great superiority in point of number of applications, but it must be remembered that the incandescent light has certain advantages over arc lamps even for public lighting, and if these advantages are desired and the system is definitely decided on, there is nothing to prevent the incandescent light acting its part with satisfaction under its own condition. It may be remembered that the arc lamps on the Forth Bridge were found to entail too much trouble and attention considering the difficulty of getting to them on the works, and large incandescent lamps were substituted with satisfaction, which required practically no attention until they were burnt out. It is, moreover, true that in America, though arc lighting in the streets is carried on almost universally throughout the country, yet there are not a few towns where the public lighting has been carried on successfully for some years with incandescent lamps. One of the most noticeable of these is that of the town of St. Louis, where a plant supplied by the Heisler Electric Light Company has been running for two years, consisting of 1,000 30-c.p. incandescent lamps in a 30-mile circuit. The lamps are run in series on a single No. 7 American gauge wire, and it is stated that seven 30-candle lamps are obtained to the horse-power. Automatic regulation of the power of the lamps is obtained, and transformers or other contrivances are not required. At Vincennes, Indiana, 150 30-candle lamps on a 15-mile circuit are used for street lighting. Other towns have 20, 150, 400 and 1,000 lamps respectively. The Thomson-Houston Company are also installing 32 and 64 c.p. incandescent lamps for street lighting in some cases, on a series circuit, on a method to which we have already referred in our issue of June 29, p. 604, by which the utmost simplicity is attained in incandescent street lighting. It is therefore clear, that authorities, or public companies, having before them the various benefits or defects of the two methods of lighting, and definitely deciding upon the adoption of the mellower and less powerful, but perhaps steadier, less troublesome, and cheaper form of lighting, can rely upon having a satisfactory supply by taking the proper means to obtain it.

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NOTES ON DYNAMO CONSTRUCTION.

BY SYDNEY F. WALKER.

(Continued from page 37.)

The difference between the resistance of the air space and that of wrought and cast iron respectively, Mr. Kapp represents by the figures 1440 : 2 and 3. This will give us an idea of the great importance of reducing the resistance of the air space. Take an example : suppose that we have a bobbin whose core is 8in. long and 7in. in diameter ; take first the distance between the core and the pole-piece as $\frac{1}{4}$in., then find the resistance of the air space by Mr. Kapp's formula.

$$\frac{1440 \times 2 \times \frac{1}{4}}{8 \times \frac{3}{7} \times \frac{22}{7} \times 7} = 9{\cdot}6.$$

The denominator representing the sectional area of the air space. Take the distance between pole-piece and core as $\frac{3}{4}$in., as in some of the older types of machines, the equation becomes

$$\frac{1440 \times \frac{3}{4}}{75} = 28{\cdot}8.$$

Now, take the first case, but with bobbin twice the length. We have, assuming the air space to be the same depth, $\frac{720}{150} = 4{\cdot}8$. What does this mean? It means that if, say, we require 100 lines of force in our armature, we shall require 2,880 ampere turns 960 and 480 respectively to overcome the resistance of the air space alone, assuming the formula to be accurate, or we have a clear gain of 1,920 ampere turns by simply reducing the layers of wire on the core so as to bring the latter closer to the poles, and we gain 50 per cent. in either case on the exciting power required for this part of the resistance by doubling the length of the bobbin. This, however, is on the assumption that on doubling the length of the bobbin we are still able to maintain the same clearance between it and the pole-pieces as with the short bobbin, and to provide the exciting power required—that is to say, that we do not reduce the winding space below that required for the reduced number of ampere-turns. If, with the long bobbin, we have to provide double the clearance of the short, we have $\frac{1,440 \times 2 \times \frac{1}{2}}{150} = 9{\cdot}6$ again, and with a long bobbin it is necessary either to allow more clearance, or to increase the strength of the spindle very considerably, the latter being an expensive part of the machine, as in turning it has far more leverage in the centre to pull the spindle out of line, or cause it to spring, than the short bobbin. The next important resistance is that of the armature core itself. It is evident that this will be less, the longer the bobbin is, and the greater its radial depth, as these two go to make up its cross section, and, on the other hand, it will be less, the smaller the diameter. The scope for the latter, however, is limited by the necessity of providing for the wires inside, and for driving, if of the Gramme type ; so that there is another gain from having fewer layers of wire, as less space is occupied inside the core, and therefore the radial depth of the latter may be greater. It will be obvious, however, that it is quite possible to have a short core whose resistance shall be even less than that of a long core. If our core 8in. long and 7in. diameter have a depth of 2in., while our core 16in. long has a depth of only 1in., the resistance of the two are equal ; and if it should be necessary or expedient from other causes to make our long core, say, 9in. in diameter, while our short one remains at 7in., and we have 1in. radial depth in the one case and 2in. in the other, then the resistance of the short core will be less than that of the long core. And this may very easily be, bearing in mind the commercial conditions to which we have to conform, the elements of friction and centrifugal force, and that of magnetic leakage, which will be considered later.

Now, consider the matter of the electro-magnets. A long bobbin almost necessitates long flat magnets, and the spindle at right angles to them, unless either the commutator be placed outside the machine, or be specially constructed. The electro-magnets may, however, be made longer, so as to accommodate the commutator on the old plan, without increasing the magnetic resistance, if they are also made of larger cross-section, and their yokes the same. There is no difficulty in doing this, and it is the plan adopted by manufacturers who prefer to keep to the old Gramme type. The reasons for doing so are principally fitting-shop reasons. It is easier and cheaper to construct the old Gramme type than those in which the bobbin is at right angles to the field-magnets. You can get a round bar of almost any size direct from the works, requiring only to be trued in the lathe, and have its ends turned and fitted, for connection to the sides. Your sides also and pole-pieces, for use with the round bar, if your patterns are carefully made and castings well done, do not require any special tools or much machinery of any kind. With the flat bars used with long bobbins a good deal of machinery is usually required. They must be planed true and fitted to their bed-plates, and then bored for the armature. You have the advantage in this case that you have no joint between your field-magnet, core, and pole-piece, the latter forming part of the former, but it is very doubtful whether in practice there is really an appreciable loss from this cause if the fitting be good. One great gain that it has, however, is in the fact that the pole-piece is of wrought iron instead of cast, though here, also, it is not difficult or expensive to make up the difference by adding to the mass and weight of the pole-piece. The magnetic resistance of the Siemens core is of course less for any dimensions than that of any other form, and it is also easier to drive, as the spindle and core become one solid mass. The objection to this form, however, is in the winding, which will be dealt with later. The magnetic resistance of the disc core is usually high, the cross-section being about the same as that of other machines, but the length, the half circumference of the disc, being larger.

There is a further source of loss—namely, that of magnetic leakage. It must be remembered that the lines of force emanating from a wire are circles, and that in the ordinary wrapping of a magnet, while they enter the iron core on one side, on the other they are open to space, and will form magnetic circuits of their own if the conditions are favourable. If anyone explores the neighbourhood of any dynamo at work, he will always find traces of evident magnetism all round it. Taking the two legs of the field-magnets of a dynamo, the lines of force emanating from the wire on the inner side of one leg will be of the opposite sign to those emanating from the wire on the inner side of the opposite leg, and they will therefore tend to form closed magnetic circuits of their own. These leakage magnetic circuits will obey the same laws as the ordinary circuits—viz., their resistance will vary directly as the distance between the wires, and inversely as the cross section. Here, then, we have an argument, and a very strong one, against the long bobbin, especially if it has a small diameter. Take our bobbin 7in. diameter. Of this, at least 3in. would probably be absorbed in the boring of the pole-piece, and a a further 2in. or more in the winding, leaving only 2in. space from wire to wire. You would have, therefore, for the resistance of this leakage circuit,

$$\text{R.L.} = \frac{1,440 \times 2}{\text{Sectional area}}.$$

Take this at 9in. × 16in., which is by no means out of the way, and bearing in mind that you have two such circuits, and you get

$$\frac{1,440 \times 2}{144 \times 2} = 10.$$

As, however, only half the wire can by any possibility come into play here, this is equivalent to doubling the magnetic resistance of this leakage, but still leaving it a serious matter, as it will be remembered that this leakage magnetism, although it is doing no work, has to be furnished by the magnetising current, and primarily by the engine, so that the efficiency of the machine is thereby reduced.

The other losses that have to be provided for are the energy expended in the wires on the armature and the so-called Foucault currents that are formed in the core itself. Both of these will be dealt with when the construction of the armature itself is considered.

What shall the field-magnets be of—single or double horse-

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shoe form, or shall they be of multiple form? In the first place the single horseshoe form effect a saving in the amount of copper wire required to do certain work, say, to create a certain number of lines of force in a given armature core. In order that two machines of different types may have the same number of lines of force passing into their armatures with the same exciting power, the resistance of their magnetic circuits must be equal. Assuming that the form and dimensions of the armatures are the same in each case, this can only be accomplished where the machines have one double and the other a single horse-shoe magnet, by making the sectional area of the core of the field-magnet of the single horse-shoe double that of the two horse-shoes; but doubling the sectional area does not double the circumference upon which the wire is wound, or its lineal surface, if flat, and as, in order to create a certain number of lines, what is required is a given number of ampere turns, irrespective of the extent of surface of the field-magnets, the single horse-shoe magnet will thereby have the advantage. To give a numerical example—say we have a dynamo of the double horse-shoe type, whose field-magnets are bars 5in. in diameter, and we wish to construct a single horse-shoe dynamo to do the same work, we require first to find the sectional area of the 5in. bar, which is 19·6 square inches. Our single magnet-bar must therefore have an area of 39·2 square inches, which corresponds to a diameter of about 7·1in., and the circumferences of the two circles are 15·7in. and 22·3in. respectively. That of the single magnet, not being double the circumference of the double one, but only about 50 per cent. more, so that in place of having to use double the amount of copper on the single horse-shoe you have to use about 50 per cent. more; or you affect a saving of 25 per cent. This, of course, is not strictly accurate, as the outer layers will be larger in proportion in the case of the single than the double magnet. With a flat bar, it is even more strikingly illustrated. Take a bar, say, 12in. × 2in. = 24 square inches sectional area. The length of wire required to pass once round it is 2 (12 + 2) = 28in. Now, double the sectional area, which can be done by doubling the thickness, or making it 12in. × 4in. = 48 square inches. The length of wire required to pass once round it is now 32in., or the increase is only as 28 is to 32—say, $\frac{1}{7}$th. The magnetic leakage is also a serious matter in the construction of the single horse-shoe dynamo. In many of these the magnets are above the armature, and they stand upon an iron bed-plate, magnetically separated from it by a sheet of zinc. Applying the reasoning that has been used in the case of the long flat magnets, it will at once be seen how serious the matter is, as the magnetic resistance of this leakage circuit is made up of that of the massive bed plate and the thin zinc plate. Where the bobbin is over the magnets of course this does not apply.

Then as to multipolar machines. As there are in these machines four, eight, or more paths for the magnetic current, if we may so term it, each of these paths may have four or eight times the magnetic resistance of the single horse-shoe magnet. In other words, in the multipolar machine, other things being the same, the iron cores of the field-magnets may have a sectional area $\frac{1}{4}$ or $\frac{1}{8}$ that of the single horse-shoe magnet; but if the exciting power is to be the same, it will entail the expenditure of a greater amount of copper wire. There are, however, two sides to the question in this case. Taking the case of our double horse-shoe magnet, with 5in. bars, and making it a four-pole machine, we can now have our bars each about 3·6in. diameter; and if we make it an eight-pole machine, we can have them about 2·3in. diameter. Now, there is practically no difference in machining a 2½in. bar and a 4in. bar, while the areas of these are respectively about 5in. and 12½in., so that by using a 4in. bar instead of a 2½in. we can reduce the magnetic resistance by a very appreciable amount, and thereby reduce the number of ampere turns and the wire required without increased cost for machining, while retaining the advantage of the double or quadruple induction. With the single horseshoe, however, the increase of an inch to the diameter will materially increase the weight and cost of machining, while the sectional area of the bar would then not equal the combined area of those of the eight-pole dynamo. There is another feature, however, to be considered in connection with multipolar dynamos. The four-pole machine has to furnish two distinct paths for the lines of force, and the eight-pole dynamo four such paths, where the single and double horse-shoe dynamos only require one path; but as the two paths and the four paths have only to accommodate a half and a quarter the number of lines that the single path has, the magnetic resistances of each path in the multipolar machine may be double or quadruple that of the single path in the others for the equivalent exciting power without any loss of efficiency. The meaning of which is, that the work being more divided, a multipolar machine may be constructed lighter than either of the others. There is also a form of multipolar dynamo made by Messrs. Elwell-Parker, Mr. Reckenzaun, and others, in which the magnetic circuit is continuous through the two inductive spaces. It has, of course, twice the resistance, other things being the same, that either of the single circuits on the other plans have.

Then if the single horse-shoe magnet be adopted, how shall it be mounted? There are at present three methods in the market. First, the Edison, where the field-magnets are on top; the legs of the magnet-bars, whether they be two or six, step into iron shoes forming pole-pieces, and these rest on a cast-iron bed plate, which carries the standards for the bearings of the armature spindles. Here we have two grave faults to find. The construction is wrong mechanically, the centre of gravity of the whole machine being too high, notwithstanding the weight of the massive pole-pieces and armature. In Dr. Hopkinson's improvement of Edison's machine, this fault is partly reduced. Further, the item of leakage across the poles may be serious; this has already been dealt with. The second plan of construction using the single horse-shoe magnets is that of Mr. Kapp, which gets over the difficulty mentioned pretty well. Mr. Kapp simply inverts his dynamo, carrying his armature and pole-pieces at the top, the magnet legs being spread out in the the form of an inverted V, so as to give stability to the structure. The standards carrying the bearings form part of the bed plates as usual. The other plan is to have the field-magnets horizontal and the armature either parallel or at right angles to the line of the field-magnets, standards being provided for one or both bearings of the armature spindle. The form of the machine is as though one set of field-magnets were cut off a double horse-shoe machine. In the Jones' dynamo, the field-magnets are horizontal, the spindle running in a long bearing extended from the yoke to the pole-piece, the armature being of the disc pattern and the pole-pieces forming shoes that encircle it on both sides for a large portion of its circumference. The long bearing is unnecessary, but it gives increased steadiness, and does away with the necessity for a second bearing at the other end.

Next, what form shall the armature take? It will have been decided by this whether it is to be long or short. Shall it be of drum pattern or ring pattern? or again on the disc or Pacinotti pattern? Shall its core be of wire, discs, ribbon, &c.? Shall it be light or heavy? There are two distinct lines that a maker can go on to begin with. He may make his bobbin very light and run it at a high speed, or he can make it heavy and run it at a low speed. From the important bearing that speed has upon the output of a machine, a maker would probably be wise, except in special cases, to make his armature light and run at a moderately high speed. As the loss by friction will depend upon the weight and speed, if you double the weight or the speed you double the frictional charge, the other factors being constant. The question of repairs and renewal comes in here. The armature is the part that has to bear most of these, so that the smaller and cheaper this can be made the better. The writer is aware that Mr. Kapp has committed himself very strongly to low speeds; but, while fully appreciating the advantage of running a heavy armature at a low speed, he sees no necessity for running a light one slowly, and he believes that you are wasting power and material by doing so. Where it is a necessity of the case that the armature shall be coupled to the engine, and you

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are unable to make the latter run more than, say, 300 to 400 revolutions a minute, you must work to these conditions, and as you must make up the loss somewhere, you may as well do so by having a large heavy bobbin, as in any other way, provided that you fulfil the other necessary conditions. There is one very simple method of reducing your speed, of course—viz., by increasing the diameter of the bobbin. The number of turns (N P) will vary as the diameter of your bobbin, and so with a bobbin of twice the diameter you can run at half-speed with the same result; but you cannot increase the diameter of your bobbin without increasing the dimensions of your dynamo as a whole—so that if you construct slow-speed dynamos on these lines you must make special patterns for them; and with a large-diameter bobbin you must have more iron in your core, otherwise your magnetic resistance will rise and reduce the efficiency of the machine once more. So that, after all, a slow-speed machine is merely a larger and more expensive machine for the same work. In other words, running a dynamo at a low speed is only one way of running it under power, and, in the writer's opinion, by no means the best way.

(To be continued.)

ROYAL AGRICULTURAL SOCIETY'S SHOW AT NOTTINGHAM.

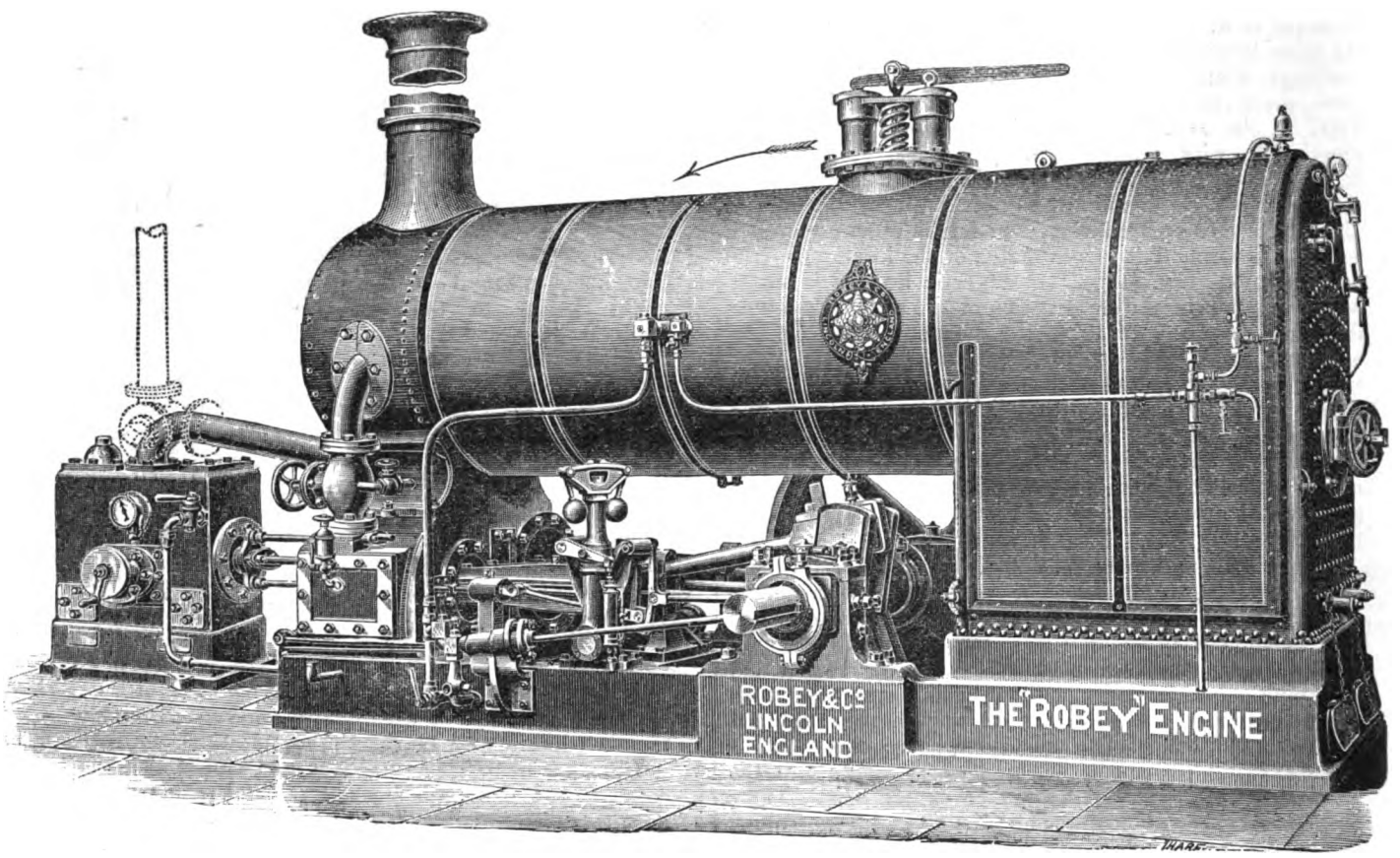
In our last issue we referred to engines of the undertype class exhibited by Messrs. FOWLER and Co., and Messrs. RUSTON and PROCTOR, and we now give an illustration of a similar engine by Messrs. ROBEY and Co., of Lincoln. The engine exhibited was a semi-fixed compound engine of 12 h.p. nominal, similar to the engines usually built for electric light installation and for driving machinery where steady running is a *sine qua non*. The working parts are perfectly balanced, so as to run safely at high speed. If we mistake not, this was the type of engine used at the Newcastle Exhibition last year, and which we saw running under various circumstances, but always satisfactorily. The boilers of these engines are made to work with 150lb. steam pressure, and are made wholly of Siemens-Martin steel. The governing of these engines, like the other cases we mention, has had special attention; indeed, Mr. Richardson is an expert upon this question, and it is to him we owe the electric governor, which can be applied to any of these engines, though usually, we believe, they are fitted with the Proëll gear. It was only in our issue of March 2 that we previously referred to this class of engine and discussed diagrams taken from one.

Messrs. ROBEY and Co. also exhibited a stationary engine for mill work, with "trip" valve gear. As it is our intention to consider specially the question of the governing of engines for electric light work, we shall defer our remarks upon this gear.

Messrs. DAVEY, PAXMAN and Co., of Colchester, at their stand exhibited only specimens of their Essex boilers; but they had working at the dairy a portable engine similar to the one which gained the society's prize last year. We have not previously illustrated the Essex boiler, which for many purposes will be found a convenient steam generator. It is a vertical boiler, and is made from 2 h.p. upwards.

From the illustration given it will be seen that a curved neck secured to the top of fire-box conveys the products of combustion into a chamber to the left, where they are burnt. This chamber is of a triangular shape in plan and has an outer flange by which it is riveted to the shell of the boiler, and a door is fitted. An exactly similar chamber is in like manner secured at the right side, and is fitted with a door and uptake, and constitutes a smoke-box. These two chambers have a number of tubes of a somewhat semi-circular shape uniting them, the curve being of a greater radius than that of the boiler, suiting it in such a way that the tubes can be easily put in or withdrawn without removing either tube chamber. The chambers are formed while hot in a special hydraulic pressing machine, and are then annealed, so that all the best qualities of the steel are preserved. The shape of the flues causes a centrifugal action in the hot gases which brings every portion of them into direct contact with the metal of the tube, so that the highest efficiency is secured from the heating surface, while at the same time full circulation of the water is secured without those violent currents which are a defective feature of other forms of vertical boiler, and which produce priming and very wet steam.

The combustion and smoke-box chambers are made of the very best mild steel, pressed out, including the flange, in



Messrs. Robey and Co.'s 12-h.p. Undertype Engine.

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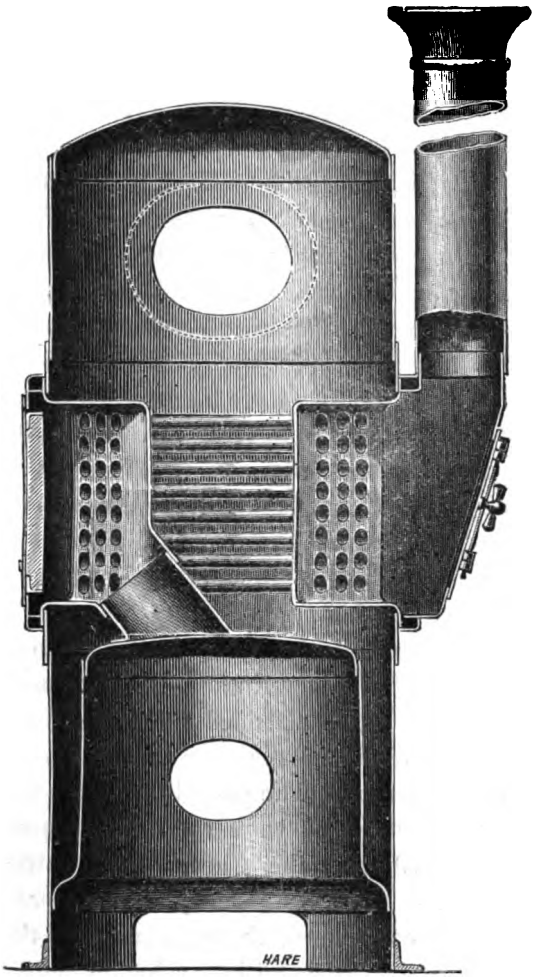
one piece. This is one of the best pieces of stamping work we have ever seen. It has been so carefully and thoroughly worked out that no reduction of area takes place, and it is of uniform thickness throughout. A little consideration will show that Messrs. Davey, Paxman, and Co. have ingeniously contrived to attain in a great measure that breaking up and "eddying" of the heated currents, causing them to impinge more directly upon the heating surface parts, which is necessary to secure the largest possible portion of the heat for the generation of steam. As will be seen, there is no part of this arrangement difficult of access, expensive to make, or liable to get out of repair.



Messrs. Davey, Paxman and Co.'s Essex Boiler.

The boiler now under notice is not only a good steam generator in which a large amount of efficient heating surface can be got into a little room, but it is essentially a strong, well-designed, and serviceable boiler. Davey, Paxman, and Co. exhibited on their stand sections of the boiler, showing how simple is its construction.

THE ANGLO-AMERICAN BRUSH COMPANY.

The following circular has been sent to the shareholders of the Anglo-American Brush Electric Light Corporation, Limited:—

The directors have reason to congratulate the shareholders upon the result of the litigation with the Edison-Swan United Electric Light Co., Limited, and take this opportunity of putting before them the facts connected with this important case.

It is doubtless within the knowledge of many of the shareholders that the Edison-Swan Co. about a year and a half since obtained a judgment in their favour against the manufacturing firm of Woodhouse and Rawson upon two patents held by them—viz., that which was considered as the fundamental Edison patent for the general principles involved in the manufacture of incandescence lamps, No. 4,576 of 1879, and that of Sawyer and Mann (known as the Cheesbrough patent), No 4,874 of 1878, for a process in the manufacture of carbon for electric lamps. These actions were gained by the Edison-Swan Company in the Court of First Instance, before Mr. Justice Butt, and subsequently in the Court of Appeal.

Following these decisions, the Edison-Swan Company commenced a system of intimidation against the users of the Victoria incandescent lamps, rendering it necessary for the corporation to indemnify all purchasers or users against loss or damage, and to call upon the Edison-Swan Company to withdraw such notice, or to take such action as would justify their procedure.

At the same time, not wishing to involve the corporation in the uncertainty of costly litigation in respect of patents which, as has been stated, had been upheld in the Courts, your directors offered to pay such a recognition royalty as should not be injurious either to the trade or to the interest of the public, provided that the Edison-Swan Company on their part would recognise also, by payment of a non-prohibitive royalty, the valuable patents of Mr. Lane Fox, the property of the corporation, which the Edison Company use in their manufacture.

These negotiations, which were initiated and conducted by your directors in the most friendly spirit, and which, from every possible point of view, were honourable and equitable to all concerned, were rejected, and the prolonged and costly litigation which has just been terminated was forced upon your corporation in defence of their rights, and to protect one of the most vital and important branches of their business.

The action was nominally brought by the Edison-Swan Company against Mr. William Holland, of Albert Palace, who was using, and the Jablochkoff Electric Company who had supplied, a large number of the corporation's lamps, and to whom the corporation had given indemnities.

Upon the application of the defendants that the Anglo-American Brush Electric Light Corporation should take part in defending the action, opposition in the courts of law was raised by the Edison Swan Company, thus endeavouring to preclude the corporation from justly protecting their own interests by defending the attack made on their lamps, but an order of the Court was obtained enabling them to defend as third parties.

In consequence of the procedure of the Edison-Swan Company, your directors considered that it was necessary to protect your interests by demanding recognition of the Lane Fox patents held by the corporation, and they therefore commenced an action against the Edison Company for infringement of two of them. This action will come on in due course, and your directors, having acted upon the best technical and legal advice, await the result with every confidence.

After an exceptionally exhaustive trial occupying 22 days, the action resulted on Monday last in a judgment in favour of the corporation upon the main issue—viz., the Edison patent, and in favour of the Edison-Swan Company upon the minor issue of the Cheesbrough patent.

The effect of this judgment is to invalidate the Edison patent, thus destroying the claim of the Edison-Swan Company to a monopoly for the "carbon filament."

The plaintiffs' Cheesbrough patent, with which they claim a special method of preparing the "carbon filament" of incandescent lamps, is upheld, and the corporation (who have always contended that they did not employ the process for the object intended and patented by Sawyer and Mann), were held to infringe this patent. This latter decision, however, in no way affects the corporation's right to manufacture incandescence lamps, and they will continue without interruption to make Victoria lamps under their own patents, which are quite independent of any process which can be considered as falling within the scope now given to the Cheesbrough patent.

With regard to the costs, those incurred in respect of the Edison patent are to be borne by the Edison-Swan Company upon the higher scale, and those incurred in the minor issue of the Cheesbrough patent, which are relatively small, are to be borne by the corporation.

It is quite possible that the Edison-Swan Company may appeal against Mr. Justice Kay's judgment; but your directors have not the slightest uneasiness as to the result.—By order of the Board, E. GARCKE, manager and secretary.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

HONOURS DIVIDED.

If half a success is satisfactory, then the litigants in the matter of incandescent lamps must be congratulated, for each side has defeated one wing of the opposition. There is no doubt, however, that when the first flush of victory and defeat has passed away, neither party will be satisfied with the result, and the case will go forward to appeal. It is unfortunate that it must be so, because the sole gainers in the end will be the lawyers. An absolute monopoly seems to be impossible, and if this fact had been recognised years ago, would-be manufacturers of incandescent lamps would gladly have paid a small royalty, which payment would have been far better for them, and far more beneficial to the holders of the controverted patents than these costly processes at law. Before we explain why it is impossible that the case can remain as it is, let us in the first place put the present position fairly before the reader. We have hesitated to report the mass of evidence that has been given, and we have no cause to regret such hesitation, as the judgment of Mr. Justice Kay is a fair summary of the position. Certain lamps manufactured by the Brush Company were supplied to the Jablochkoff Company, and used at the Albert Palace. The Edison and Swan Company believed the manufacture of these lamps to infringe patents held by them, and thus believing were obviously entitled to test their belief at law. An action was commenced, and has really been defended by the Brush Company, who gave an indemnity to the purchasers and users of the lamps. The patents which it was contended were infringed were the Edison patent No. 4,576 of 1879, and the Cheesbrough patent No. 4,874 of 1878. It is unnecessary for us to enter into much detail concerning these patents, for they are household words with all interested in lamp manufacture. There exists a widespread feeling of discontent among those who fancy a good business can be made by the manufacture and sale of lamps, that hitherto these patents have been upheld. It is but natural when an article is in extensive demand to envy the patentee, and human frailty is apt to try if it cannot in some way or other get round the patent and take a share in the profits. Thus it is that men with money and brains seeing that incandescent lamps would command an increasing sale are hoping to break down the patents, and so be able to commence to manufacture at once. We are wandering, however, into an homily on attempts at money making. The parties mixed up in the case just finished stand in a different position towards each other, that many other parties—Edison, Swan, and Lane Fox—were each and all investigating and patenting about the same time. It is and it must be admitted that they were working more or less independently of each other, and suppose we admit their investigations ran somewhat on the same lines,

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the sole question becomes one of priority of date and validity of patent. Our readers must read the judgment, as given elsewhere in our pages, with close attention to understand the position we take in the matter. We must confess that even after once or twice reading the judgment we were not prepared for the criticisms urged against it, and for which we are indebted to a legal friend who has had a unique experience in patent law, and especially so far as it is connected with incandescent lamps.

The judgment of Mr. Justice Kay was to invalidate Edison's patent, so that, so far as this part of the case was concerned, the Brush Company were victorious, and, in the second place, to hold that the Cheesbrough patent had been infringed, and thus, so far as this was concerned, to grant an injunction.

We are fully aware that what we are about to say is contrary to the opinions expressed by some of the eminent legal luminaries engaged in the case, but nevertheless the fact will have to be considered, and for the moment we see no reason why on appeal this judgment should not be reversed. If the anxiety of waiting the result of appeal is to be undergone, the sooner the final solution is arrived at the better. Our wish is to see no more litigation, but if it cannot be avoided, to see it over as quickly as possible. Mr. Justice Kay held that Swan's lecture experiments did not anticipate Edison because "*these were experiments which did not succeed in providing a commercially successful result before Edison's patent.*" On coming to the reasons for invalidating Edison's patent Mr. Justice Kay said: "*Secondly, because his specification does not describe a lamp which ever became or, as I think, could have become commercially successful.*"

The contention we have to put forward is that not being *commercially* successful is no reason for the invalidation of a patent. The facts of the case would be these. Edison, or Swan, or Lane-Fox would commence to experiment. For argument sake, let us stick to Edison. He would arrive at certain results, which admittedly show how to make lamps, some of which burn at least 60 hours. These results he would hasten to patent, and so obtain the groundwork of protection for his work. The experiments would not cease, but would result in further improvements. These improvements would be patented and assume the place of satellitic patents round the central luminary patent. The commercial lamp would be manufactured according to the most improved method found out, but surely that fact does not invalidate the original patent. If it does, no patent is valid unless it specifies a perfect machine, or rather the patent specifying the most perfect machine invalidates all patents on the subject taken out before. Mr. Justice Kay's contention is, we believe, diametrically opposed to that of Sir George Jessel in Otto *v.* Linford, wherein it was set forth that of course experiment and improvement follow after experiment, and patent follows after patent; the commercial article being that manufactured according to the latest improvements.

Whether Mr. Justice Kay's judgment will be upheld because of the other reasons given is a matter upon which we offer no opinion, but to make the validity of a patent depend upon whether or no the article has succeeded commercially, as manufactured according to the specification, is a matter that cannot by any possible means be allowed to be recognised till it has been upheld by a higher jurisdiction.

There is much more to be said on this question of patents. Rumours are already rife as to what lamp manufacturers are going to do now they can and will make lamps without infringing the Cheesbrough patent, but we must advise caution. *Mora omnis ingrata est, sed facit sapientiam.* We have strong opinions about monopoly; about the validity and invalidity of certain patents; about the advisability of litigation; but our opinions are not stamped with the impress of the law, and may be incorrect. Consider the position if this case goes to appeal, and the judgment, so far as Edison's patent is concerned, is reversed. Is not Swan's patent the next in importance, and if so, how far do subsequent patents trespass upon and the manufacture infringe this? The Seel Company, Westinghouse Company, and others again contend that their patents are absolutely outside the Edison-Swan combination, and if this is the case, no doubt the latter must depend for immediate success—as under any circumstances they must do in the course of three or four years—upon excellence of manufacture and cheapness as regards selling price.

ELECTRIC LIGHT RULES.

We had hoped that all difficulties with regard to duplicate electric light rules had been overcome, and that we should hear no more of the subject. We are informed, however, that not only is the subject not dropped, but that a fresh attempt is to be made to force another set of rules down our throats. No doubt the electric light engineer is a long-suffering person, but there certainly is an end to his patience and that end has been reached in all that concerns such rules. It may be well to speak plainly to the busybodies who are trying to force these new rules forward. The profession will not have them, nor will the public tolerate them. It is quite enough to be compelled to work in accordance with one set of rules; but if variations playable at the sweet will of any single or any collection of offices in antagonism to the principal offices are to be put forth, the sooner the instrument of torture is stopped the better. There cannot be two different rules about the same thing, and both be right. If, on the other hand, the rules are the same, where is

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the need of a duplicate set? We have now in existence the Phœnix rules, which have been elaborated after years of experience, and in consultation with the best known electrical engineers, fortified, so to speak by the society's rules, which, as was indicated in the recent discussion, are not intended to be anything more than scientific guides determining the theoretical lines upon which the practical rules must be based. There is no indication that the proposed new rules have been drawn up as the result of experience or after consultation. Their only object can be, in the first place, to sow dissension among the offices, and, in the second place, to exasperate the practical men who will never know from day to day what changes will take place, or what differences will arise between the various sets of rules. It is necessary to be emphatic upon this question, as the late constant agitation is detrimental to increase of business. Great latitude must necessarily be allowed to fire offices in their method of conducting business, but in the question of these rules there is no room for latitude; for saying the same thing in different words does not constitute a different rule, and the multiplicity is exceedingly vexatious to the engineer, who has to interpret the language and find out exactly what the author means. The door is opened for bad materials and workmanship, and this will surely result in loss to the offices. Whichever way the matter be looked at, alternative rules will be found to be a mistake, lead to endless trouble and confusion, and rouse angry feelings amongst those who should be working harmoniously together. It is to be hoped, therefore, that this new attempt to foist more rules will be met with a decided negative.

CORRESPONDENCE.

HOT BEARINGS.

To the Editor of The Electrical Engineer.

Sir,—One cannot but admire Mr. Thackeray's ingenious application of the Bourdon tube in his instrument for the detection of hot bearings, but his arguments do not convince me that there is a demand for such appliances. I think he defeats his own argument, in that whilst speaking of the difficulty of "feeling" the crank-pin of a fast-speed engine he gives as an example "ships being brought up," &c. Query—What ships (excluding such as torpedo boats) use fast-speed engines?—Yours, &c.,

London, W., July 17, 1888. F. Broadbent.

A TRADE ASSOCIATION.

To the Editor of The Electrical Engineer.

Sir,—The subject of forming an association to represent the commercial interests of the electrical industry has been frequently under discussion during the past few years, and there is apparently a concensus of opinion in favour of some kind of organisation being formed to secure united action; but the chief reason why the past attempts to establish such combination have failed is the difficulty of defining the scope and limits of the proposed association.

We all recognise the necessity for combination in matters of common interest; but we are not all agreed as to what our common interests are. This is probably attributable more to the peculiar conditions of the industry in this country than to any fundamental difference of opinion. My object, however, is not to discuss this, but to point out how I think the difficulty referred to can in a large measure be overcome.

The proposition before us now is that we should assist the London Chamber of Commerce to form an Electrical Trades Section. This is not a new idea, for it has often been spoken of, and was suggested by me to the Chamber more than a year ago. There were, however, at that time difficulties in the way of the scheme being carried out, but now that the Electric Lighting Act has been amended, we may expect the industry to enter upon a new phase, and united action will become more important than ever.

We are indebted to the editors of *Electrical Plant* for reviving the suggestion that we should avail ourselves of the organisation of the London Chamber of Commerce, and in view of the public meeting which the Chamber will shortly convene in regard to the matter, the present is an opportune time to point out the advantages which the proposed arrangement offers.

The Chamber consists of firms and individuals, and anyone feeling an interest in the transactions of the Chamber can become a member upon payment of an entrance fee of two guineas and an annual subscription of one guinea. Its work is divided among different trade sections, which are again divided into sub-sections according to the needs of the respective industries.

The sections are composed of representative men, selected from the members, and one member of each section is elected to the General Council. In this way each trade is brought into communication, through its representative, with all the other trades represented by the Chamber, whilst the various trade sections are not precluded from taking independent action in regard to their own esoteric affairs. The status possessed by the Chamber would at once secure to the electrical industry an influence in Parliamentary and official matters which would be practically unattainable by a separate association formed under existing conditions. The Chamber has been established many years, has done much good work for other industries, and its organisation and its mode of procedure are well defined and intelligible, and the secretary of the Chamber has had a large experience in the best methods of promoting and defending trade interests. We should therefore have the enormous advantage of being relieved from the unprofitable work of defining the precise functions of an organisation and of settling its constitution and rules. All that is necessary is that those who are concerned with the commercial interests of the business should allow themselves to be nominated as members of the Chamber, and then elect a representative section or committee. We should not have to concern ourselves with questions of ways and means, for all necessary office accommodation, staff, and a good central place of meeting would be provided for us by the Chamber.

The monthly journal and the annual volume of proceedings published by the Chamber afford means of inter-communication, and of permanently recording the work of the Chamber in regard to our affairs. The facilities of the Chamber for obtaining reports on the state of the industry in other countries, and for collecting statistical information, are such as no separate association that we could form at present could hope to secure. The following extract from a recent annual report of the council will indicate the special advantages offered to individual members: "Although the more immediate object of the Chamber is to serve the interests of members in their collective sense, it is also sought, within the limits of impartiality and fairness to assist individual subscribers, not only by the communication of information as to treaties, tariffs, prices, foreign legal procedure, foreign exhibitions, the registration of trade marks, and the issue of certificates as to local trade customs, but also by the influence of the Chamber being employed to obtain the support of H.M Government to members' interests in foreign countries. It is not too much to say that there is very little information in or out of the office which cannot now be obtained and transmitted with the least possible delay."

It may perhaps be urged as an objection to the proposal that those members of the industry who are resident in the

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provinces would feel themselves excluded, but the membership of the Chamber is not limited to persons residing in the metropolis, and the inconvencience to which country members are put by the meetings being held in London must necessarily apply to every organisation having its headquarters in London. On the other hand, those members of the industry who join the provincial Chambers of Commerce are brought into communication with the members of the London Chamber by means of the Associated Chambers of Commerce, a central body which represents now some 70 Chambers of Commerce in all parts of the United Kingdom.—Yours, &c., E. GARCKE.

Belvedere-road, S.E., July 16, 1888.

ELECTRICAL ENGINEERS.

I.—MESSRS. R. E. CROMPTON AND CO.

In view of the rapid extension of the electric lighting industry that is now likely to take place in consequence of the passing of the Electric Lighting Amendments Act, we shall take the opportunity of giving a series of articles descriptive of the works and resources of our prominent electrical engineering firms and companies, with special reference to their facilities for complete and extensive dealing with the problems now before the profession in the question of designing, manufacturing, contracting, and carrying out of large installations for central stations for the public supply of electric light.

We are of the opinion that the delay to the extension of electric light in this country, owing to the first deleterious effect of the first Electric Lighting Act, is by no means an unmitigated evil, and that, however, we may, with disappointment, regard the great extension of the light in America and elsewhere, as compared with the very modified application for public use in England, it cannot but be felt that the loss of time which has taken place will be far more than compensated in future by the greater security, and the better and more scientific methods of dealing with the great problems involved, than would have been possible had the work been tackled at the outset with only the knowledge possessed on the early development, before real and solid engineering experience was grafted on to the inventions of the electricians. Municipalities and vestries almost innumerable have been quietly and industriously investigating the question, and more or less fitting themselves for dealing in a practical and complete manner with the introduction of the light in their localities as soon as the present Act should take effect. Sufficient capital for new companies will not be wanting when it is seen that there is a reasonable prospect of good return for the outlay, and there is little doubt that the capabilities of our electrical engineers will soon be taxed to the utmost.

Themselves keenly alive to these possibilities, Messrs. R. E. Crompton and Co., of Mansion House-buildings, E.C., and Arc Works, Chelmsford, have taken time by the forelock, and last week issued invitations to a number of the daily press, together with the technical journals, and arranged a day of inspection of their works with the idea of pointing out the facilities which they now possess for taking in hand contracts on a large scale. The works of Messrs. Crompton and Co., situated in a charming and convenient country locality, easily allowing any desired extension, and at not too great a distance from London, were started at first on a small scale, and have grown with the growth of electrical engineering, and now occupy an extent of six acres in area. The workshops throughout are conveniently laid out, and are kept very clean and neat in all departments, everything seeming to be in order and under first-class management.

POWER AND MACHINING DEPARTMENT.

On the ground floor, we see the long machining-room, with power lathes, planing machines, drilling and shaping machines of latest patterns busily turning out dynamos both of little and of giant size, and all kinds of electrical fittings. The machinery for the whole works is driven by two engines placed in one compartment of this floor, indicating respectively 80 and 30 h.p.; steam for these is supplied from boilers at the back at 140lb. pressure. One of these engines can be driven separately, for testing the new dynamos as they are finished, on a special bed-plate, to which they can be bolted; and as in many cases the present system of dynamo running seems to tend towards direct driving with high-speed engines, a special shafting with bolted flange can be used for testing such dynamos, as if they were run direct, in exactly the manner they are to be used.

FOUNDRY AND FORGE.

To the back of the machine shop is a well-appointed foundry, with appliances for making the copper and other castings necessary for electrical work. Commutator pieces and bearings, parts of heavy switches, contacts, plates, &c., are here in progress. One interesting and time-saving idea is that of casting copper contact screws with the screw threads already in them, by means of a screw core to the pattern-box. The screws thus cast require, of course, but little surface-turning.

A separate building is devoted to iron-forging; smiths' anvils of the ordinary type are supplemented with a steam hammer, with which, by means of various shaped anvils and bosses, the iron parts required in the work can be rapidly turned out. The eyelet screws for lifting the dynamo are forged under the hammer at white heat with practically but two or three blows and deft movements of the forgemen, and need little but filing the edges to render them fit for use. Other parts of machinery are equally able to be dealt with.

WOOD SAW AND PATTERN SHOP.

A large amount of wood is required, both for making up of parts, and for making the various patterns required for the machinery. The circular saw used in cutting the wood is driven by an electric motor, which answers its purpose admirably as a wood-cutter. One of the old type of Crompton machines is run backwards as a motor from current supplied from a central dynamo, and the normally high rate of revolution of an electro-motor is, of course, advantageous in this direction. Its use is as simple as can be desired, a cross-bar moved by the workman moving a switch on or off, and the motor starts at full power almost instantaneously. A further motor is used to drive the shafting and belts for the lathes and drilling machines of the pattern shop, and perform its part with all satisfaction. In this department, which may be called one of the highest of mechanical skilled trades, numerous clever workers were engaged in turning out patterns of the latest required details of the large switch-boards and electric crane machinery now on hand.

TESTING DEPARTMENT.

The testing department is one of the most necessary in an electrical engineering works, and great care has been taken to get all the necessary apparatus in as convenient a shape and arrangement as possible. Wire and cables from the dynamo machines are led under the floor to convenient boxes, to which connection can be made for testing any new dynamo. Resistances are ranged in large coils outside in the archway, where they can be kept cool, and an arrangement of wire gauze resistance is also fixed up, where, on occasion, as much as 150 h.p. can be absorbed. For additional work, a water resistance, with lead conductors, in a tank which can be filled with water, is also kept handy. A large switch-board on the back wall inside allows of any arrangement of connections. A dark room, furnished with a D'Arsonval reflecting galvanometer, Wheatstone bridge, and other measuring apparatus for testing the resistance of the armatures, &c., is also provided. In the office is also a very delicate apparatus, with standard cells and reflecting galvanometer for use in calibrating the instruments.

WINDING DEPARTMENT.

On the upper floor, above the heavy engineering department, is the winding department. This is kept quite distinct from those where any purely mechanical process is carried on to keep the wires from being damaged in any way from flying particles of metal which might damage the insulation and cause short circuits. The process of winding the magnets in coils by the lathe is carried on here, and on the same floor is carried out all the work connected with the armatures of the machines. The steel spindles come

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from the large shop below, and are fitted with soft iron discs, forming the core of the armature, which are stamped out of the required shape by the stamping machines below. These cores, after being very carefully balanced, are insulated, and then have the winding put on to them. This operation of winding, which, as its name implies, used really to consist of winding comparatively thin wire over the core, now in almost all cases of the larger class of machines consists of fixing on large strips or bands of copper insulated from one another by plates of mica and other insulating material. Great attention has been paid to various systems of building up this winding, so as to enable armatures to be easily repaired when away from the workshop. On this floor quite recently might have been seen the largest armature hitherto constructed in the world for continuous current machines, now at work at Milton, Staffordshire, for supplying current for smelting aluminium direct from the ore by the Cowles' process. This huge armature is in regular work to carry a current of 5,000 amperes, and it is doing its work very satisfactorily. The largest armature shown in the works is that belonging to a slow-speed machine, for a new central station belonging to the Liverpool Electric Supply Company, and is capable of supplying current for 5,000 lamps driven at a speed of 720 revolutions. This dynamo is wound in accordance with a new patent of Messrs. Crompton and Swinburne. The armature has a clear passage through the centre, which admits a perfect ventilation, which had hitherto been considered impossible with this form of armature. Fourteen armatures of approximately the same dimensions as this one have, within the last twelve months, been made in this department, besides a large number of smaller ones. Here can also be seen in course of construction a new form of armature for an alternating-current dynamo, of which great things are expected. It is built to give 2,000 volts and 32 amperes at 400 revolutions per minute without excessive heating, which is a very progressive result considering that this output is nearly eight times that given by a Westinghouse machine of the same size. This dynamo is made according to another patent of Messrs. Crompton and Swinburne, which has lately excited considerable interest, the armature wire being wound in holes, so that there is an unbroken surface of iron, and thus a very small clearance between the armature and the field-magnets. The field-magnets are of purest and softest wrought iron, made out of solid forged ring nearly 3ft. in diameter, turned and then slotted out in recesses to receive the coils.

Draughtsmen's Office.

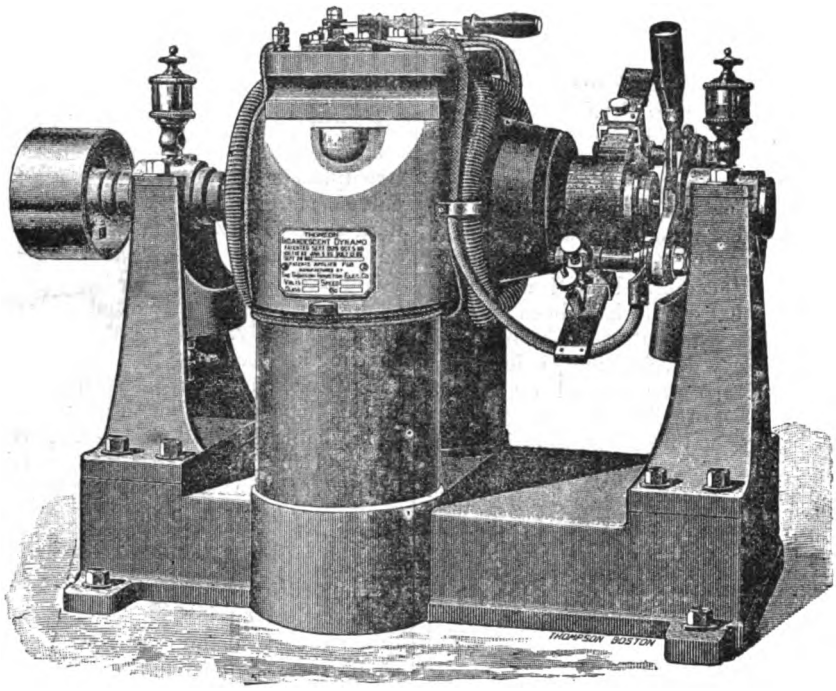
A separate and well-lighted office employs quite a contingent of draughtsmen working out the designs for projected contracts, or making the plans and detailed drawings required in the manifold processes proceeding on the works. Here can be seen plans and details of the Vienna central station, the apparatus for Whitehall, tramcar work, new dynamos, electric cranes, gun training apparatus, plans for public building and private house lighting in profusion.

A number of very interesting examples of electrical engineering at present in progression at Messrs. Crompton's works, with experiments, were shown, consisting of the giant switchboards for the Whitehall accumulator system installation; automatic accumulator cut-out; a new and special gun-training apparatus, worked by electric motors, travelling either right or left on a radius, and elevating or depressing the gun at will, by the action of two small electro-motors, easily controlled from one handle; an electric crane for the roof of a warehouse, for unloading timber, which will raise one ton 8ft. per minute, travelling, slewing, and hoisting, by means of an electric motor. These we shall describe next week with full illustrations.

(To be continued.)

NEW THOMSON-HOUSTON DYNAMO.

This new dynamo, the illustration of which is given by the New York *Electrical Review*, possesses many valuable features. It is made shunt-wound, to supply a demand for a machine for the charging of storage battery cells, and series shunt-wound for direct lighting. This machine is perfectly automatic in its regulations, so that any load can be carried from one lamp to the full capacity of the machine, and lamps may be turned on and off without readjustment of the brushes, or giving the dynamo particular attention. Every part is proportioned for durability and simplicity. The commutators and brushes are easy of access. It is compact, and occupies small floor space.



New Form of Thomson-Houston Incandescent Dynamo.

THOMSON'S NEW ELECTRIC WELDING APPARATUS.

For the last few months work has been actively pushed in the factory of the Thomson Electric Welding Company, at Lynn, Mass., in the perfection and standardising of apparatus employed in the ingenious electric welding process of Prof. Elihu Thomson. This work has now so far progressed that the company is ready to supply machines for electric welding, and the new form of the machine is shown herewith.

The illustration represents what has been named the "in-

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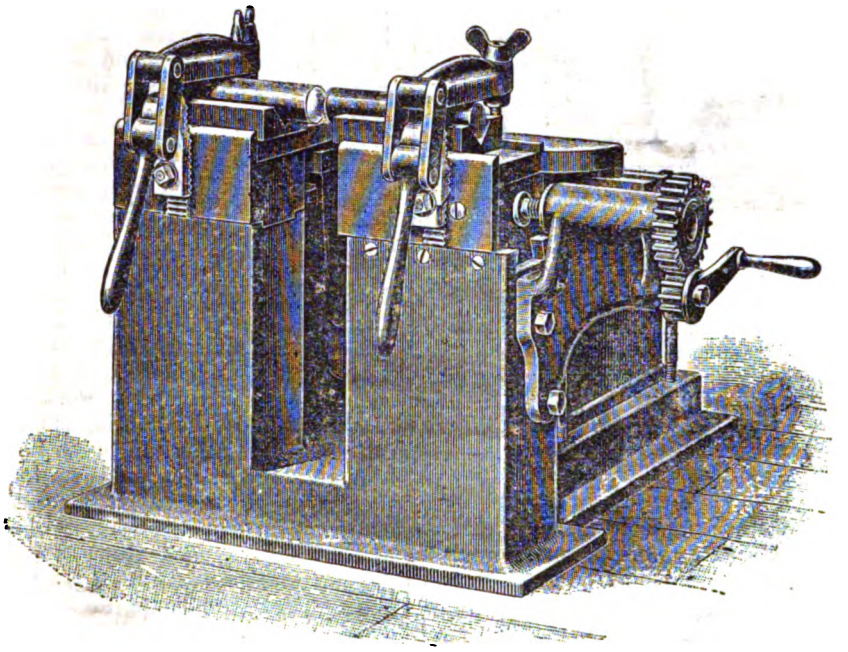
direct" welding machine. In this an alternating current is supplied to a converting coil placed within the case, and fed from a dynamo at a distance, the high tension current being transformed into one of low tension and of large volume. The front of the iron case carries adjustable clamps at the top, between which the pieces to be welded are fastened, and a crank at the right hand serves to screw the pieces into firm contact to effect the weld. By employing the converter, the machine becomes very light for its power, so that it may be placed in any convenient location more or less distant from the dynamo and engine. The machine illustrated is designed for moderately heavy work, such as welding metal bars up to about two inches in diameter.

The "direct" welding machine is another form, combining both the dynamo and welding apparatus, and consists of a machine having two windings on its armature. One of these windings gives an alternating current, which is taken off by two wide brushes bearing against collector rings, seen directly under the welding table. The alternating currents are led directly to the welding clamps, and are under the control of the switches at the left-hand side of the table.

The other winding on the armature is connected to the commutator placed at the front end of the machine, which rectifies the current for the excitation of the field-magnets. By means of this arrangement the strength of the welding current can be regulated to a nicety by varying the strength of the field-magnets, which is accomplished by shifting the brushes by means of the handle attached to the brush-holder, which is provided for that purpose.



Latest Form of Thomson's Welding Machine.

This machine is designed for all kinds of light work, its capacity, however, ranging from fine wire to rods 2½in. in diameter.

It has been found that the power required for the different sizes varies nearly as the cross sectional area of the material at the point where the weld is to be made.

By the use of these machines an endless variety of work can be performed, not only in welding pieces of like or different material, but also in shaping, bending, forging, and tempering metals. Welding is destined to be one of the greatest of the electric arts.—*Electrical World.*

AERATION CURRENTS.

Dr. C. R. A. Wright and Mr. C. Thompson, in a recent paper before the Royal Society, of which an abstract is given in the Chemical Society's *Journal*, state if different aëration (spongy and smooth platinum and gold) plates are placed above the same oxidisable metal in dilute sulphuric acid or aqueous potash, and left until a constant aëration is obtained, and if they then are connected together, a current is set up, which lasts with decreasing intensity for several days, and which at starting has an E.M.F. equal to the difference between the E.M.F.'s obtained by exposing each plate to the oxidisable metal. The passage of the current electrolyses the sulphuric acid, with the result that the aëration of the positive plate is reduced, whilst that of the negative plate is increased. If the current is interrupted for some time, the plates recover their original aëration. With silver plates in sulphuric acid, acetic acid, and aqueous ammonia, a stronger current is obtained, the silver passing into solution; moreover, the amount of silver deposited in a voltameter by the current is less than that dissolved in the cell. The difference is greater with feeble than with strong currents. If the silver is opposed to a powerful oxidising agent such as platinium in nitric acid, the current produced is stronger, but the discrepancy between the quantity of silver dissolved and that deposited remains.

Other metals dissolve in the same way, thus mercury opposed to an aëration plate gives mercurous sulphate. Gold in potassic cyanide gives potassium auro-cyanide. Palladium behaves in a similar manner. If platinum in chromic acid is substituted for the aëration plate, gold can be dissolved in hydrochloric acid, forming aurous chloride which subsequently decomposes.

GAS COMPANIES AND ELECTRICITY.

Our energetic friends connected with the gas interest are determined to keep well before them the question of competition between gas and electricity, and a paper on this subject was recently read at the Ohio Gas Light Association by Mr. F. W. Day. After discussing general questions, the author of the paper went on as follows:—

"The sceptical will no doubt, 'What has all this to do with us?' Let us see. 1st. The introduction of an incandescent plant into the business district of a town means the loss of the gas consumption of at least one 5ft. burner for each incandescent lamp used. 2nd. The cost of a plant would depend largely on whether the direct current three-wire or the alternating system were used, and this, as also the cost of running it, would depend on the circumstances under which the plant was to be operated—the distance of the lamps from the station, the difference in the commercial efficiency of the generating apparatus, all coming in for due consideration. We will suppose that the system requiring the least capital was embraced—we are told that the amount of investment, including land, buildings, steam plant, and complete generating and distributing

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apparatus erected and ready for use, would average 25dols. per lamp. Adding 10 per cent. to this as a factor of safety, would make a 1,000-light cost 27,500dols.

"The third question requires more in reply. We will take, for example, a plant located in a town, the business portion of which would use 1,000 16-candle lamps. With a 16-candle per 5ft. gas, selling at 1dol. 50c. per 1,000 cubic feet, taking four hours as the average daily usage, the total consumption displaced per month would be $1,000 \times 5 \times 4 \times 30 = 600,000$ cubic feet, which at 1dol. 50c. per $1,000 = 900$dols., or an average of 90 cents per month per burner. Allowing for leakage a little less than 8 per cent., the net profit on the gas sold at that rate to pay 10 per cent. on the capital invested would be 55 cents per 1,000 cubic feet, or 3dols. 30c. per month of 30 days. This would be the net reduction of the profits accruing to the gas business resulting from the introduction of 1,000 incandescent lamps, if current was supplied from 6 p.m. to 6 a.m. Now suppose the lamps were furnished at the cost of a 5ft. tip—namely 90 cents per month—the income from the 1,000 would be 900 dols. per month. No meters being used, the charging consumers with the cost of renewals of lamps, the company guaranteeing them to last 800 hours, would have a tendency to limit the hours of use to those specified in the contract; but they would still burn them more than they did the gas jets." Mr. Day estimated that the hours of use averaged 5·4 hours per days. "They would cost," Mr. Day continued, "with a consumption of six pounds of coal per h.p., and an average efficiency of eight 16 c.p. lamps per h.p., with coal at 2dols. per ton:

125 h.p. 4 hours = 125 × 4 × 6 =	1,500lb.(?)
50 ,, 2 ,, = 50 × 2 × 6 =	600 ,,
12½ ,, 12 ,, = 12½ × 12 × 11 =	1,650 ,,
Coal used for banking and starting fires	350 ,,
Total	4,100 b.

4,100lb. at 10 cents per cwt.	$4 10
Water, at 30lb., per h.p. per hour = 2,644 galls., at 50 cents per 1,000 galls.	1 35
Proportion superintendent's salary	2 00
Engineer and station man	3 00
Fireman	2 00
Day watchman	1 65
Lineman and helper	2 50
Repairs to engines, boilers, and dynamos, at 5 per cent. on investment	15 00
Oil	1 00
Interest, insurance, and depreciation, at 16 per cent.	12 25
Taxes	60
Making total daily expenses	$32 00
For average month	32 × 30½ = $976 00

"The income being 900dols., this would make a net loss of 76dols. per month. If placed at 90 cents for those used until 10 o'clock, at 1dol. for those used until 12 o'clock, and at 2dols. 70c. for those until 6 a.m., which would be the cost of a 5ft. gas-burner burned all night, the total income would be 1,060dols. per month, less 976dols. expense, would leave a net profit of 84dols. per month, or 1,008dols. per annum, a little less than 3¾ per cent. on the capital invested. A plant under these circumstances would hardly be called a bonanza. In cases where, as Mr. Wood suggested, the waste heats could be used to such an extent as to save 50 per cent. of the fuel, and the balance could be made up of coke breeze, costing 1 cent per bushel to handle, the expense of firing would be reduced at least one-half, making the whole cost of production per day:

For fuel, 2,050lb., at 1 cent per bushel	$0.52
Other expenses	27.42
Total	$27.94

In round numbers, 28dols. × 30½ = 854dols. for average month. With an income of 1,060dols., and an expense of 854dols., we have a profit of 206dols. × 12 = 2,472dols., or nearly 10 per cent. per annum on the capital as estimated by the Westinghouse people. By the operation of an arc plant in connection with the incandescent, some of the items would be divided, making net earnings considerably larger. The cost, as estimated here, is no doubt larger than it would be placed at by the electrical engineers, but we had better err on the safe side. The manufacture of a cheap fuel gas made use of in gas-engines, together with the advantages of cheap and efficient storage batteries or accumulators, would lower considerably the amount of first investment, and at the same time cut down immensely the cost of production. However, it will not be long now until our energetic hosts will again be able to give us the benefit of their experience with their new venture, they being now engaged in putting in an incandescent lamp. It would seem, from the figures here given, that gas companies are much more favourably situated for furnishing both arc and incandescent lights, or electric currents, than anybody else; and that they should pursue the policy of fortifying themselves in their present positions by obtaining authority so to do—if necessary. Keep an eye on the public pulse, and if they will have it, give it them. By so doing they would make a powerful ally of what might, under some circumstances, be a formidable foe. Failure to occupy a field of action in advance of others sometimes results in disaster."

BRUSSELS EXHIBITION.

Though the electric light is largely employed for the illumination of the Exhibition buildings and grounds at Brussels, it does not appear, in the conception of the original scheme, that this very efficient aid to a successful exhibition was sufficiently considered and provided for. Hence, although gas was extensively laid on, it was found after the date at which the Exhibition should have been opened to the public that a very large increase would have to be made in the plant for electric lighting. It is a matter of regret that arrangements for the electric lighting did not form part of the original programme of the committee, as they have thereby missed an opportunity of bringing together in one place a most interesting exhibit, showing the advances made by the several representative companies who have taken to Brussels examples of various forms and types of electrical apparatus, but which, owing to their being distributed in various parts of the Exhibition where the public are least likely to find them out, receive very little notice, and the results of comparison are to a great extent lost. The interior of the Exhibition is principally lighted by arc and incandescent lamps supplied and maintained by Messrs. Thomson-Houston, Shuckert, and L'Electrique, a Belgian company working on the Brush system. In the grounds the lighting is divided between H. Pieper and the Anglo-American Brush Electric Light Corporation, Limited. Pieper's installation has been working some time to a partial extent, but owing to there being a deficiency of boiler power, the total number of lamps installed have not been regularly at work. The Anglo-American Brush Electric Light Corporation, Limited, have 58 lamps of 2,000 c.p. in operation every evening. These are distributed as follows: Ten in British section, six at the switchback railways, six on the high mast opposite the entrance from the Rue de la Loi, and 18 on independent masts all round the grounds. Eighteen lamps are set apart for the illumination of the arena, which was originally intended for the performances of the hippodrome. These, however, came to an abrupt termination, but the lamps are still there, and effect a very useful purpose, as they light up a large space which is the principal thoroughfare from the exhibition buildings to the grounds, and bring into relief one of the most beautiful architectural features of the Exhibition.

BALANCING MOVING PARTS.

A very pretty little controversy is going on in the American technical press on the balancing of moving parts. Prof. Sylvanus Thompson is evidently not a name to conjure with in America. At any rate, here is a man to set him right (though he thinks it "hardly worth the while") on a fundamental point, to whom the position is obvious after an hour's experiment. Mr. Charles Seymour, dating from Defiance, O., writes as follows to the editor of the *Electrical World*, New York:—

"Sir,—In your issue of December 17th, 1887, in an article by Prof. Sylvanus P. Thompson occurs the following sentence: 'Every engineer worthy of the

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name knows that a thing so balanced as to stand in any position is not necessarily balanced for running; that a four-pound weight at three inches from the axis of rotation, though balanced statically by a one-pound weight at 12in. from the axis, is not balanced by it dynamically, for the moments of inertia about the axis are not equal. On the contrary, a four-pound weight at 5in. is balanced by a one-pound weight at 10in. from the axis.'

"It is often difficult to find the springs which prompt to controversy. Perhaps we are not answerable for the motives. When a man stumbles physically, we help him up. If he stumbles mentally, we are barbarously apt to goad him And why? Because it sometimes affords us amusement to indulge in the psychological exercise of tracing, or of endeavouring to trace, the paths by which the human mind gets astray in a labyrinth of error. But it is hardly worth the while. That Prof. Thompson is in that position is obvious to any man or boy who has experimented an hour with lever and weights and has reasoned on their functions. He needs no other apparatus than these simple elements to show all there is of the law of virtual velocities, all that exists of the ties by which the busy universe is kept in equilibrium, and all that is needed as a compass to lead him back into proved and well charted fields.

"A rotating body, balanced 'dynamically,' is balanced statically. There are machines for practically proving this in nearly every principal town in America And some of those machines are proving a hundred times a day that a rotating body balanced at one rate of speed is balanced for all rates of speed.

"What there may be of an intermittent character in the shape of electrical resistances in a dynamo, as to produce troublesome jars while running, is not now brought into question. The vibrations or jarring caused by the unbalanced rotating parts of machinery are owing, not to the centrifugal force of excessively heavy portions, but to a striving, as of all rotating bodies, to assume rotations upon their centres of gravity. If it be desired that a rotating body run smoothly without jarring its adjuncts, its qualities must be the same as those of a body rotating in space, having a mechanical centre upon which it is desired it shall rotate and a mechanical plane in which it is desired it shall continue. Now this is not difficult to understand, and it is so fortified by mathematics and by mechanical experiment as to be impregnable.

"'A thing so balanced as to stand in any position is not necessarily balanced for running,' says Prof. Thompson. It is only by running that the centre of gravity of any mass can be mechanically found. There must be a *running* in some degree; if not that of complete rotation, it must be that of complete oscillations in arcs of circles like those of scale beams and levers. When by such means the centre of gravity of a mass be found, and the mass be poised thereupon, it can be rotated in any plane, and at any degree of velocity, and cause no more disturbance to its supports than when standing still. This has been proved in practice during every working hour for years, and is so axiomatic as to seem tame. Yet it proves that 'a 4lb. weight at 3in. from the axis' and 'a 1lb. weight at 12in. from the axis' *have* equal moments of inertia, and balance each other under all conditions of rest or revolution."

The question is taken up by Prof. William A. Anthony, of Manchester, Conn., who replies as follows:—

"Sir,—In your issue of June 16 I find a letter from Mr. Charles Seymour, in regard to a rotating body, in which a quotation is made from Prof. Silvanus P. Thompson, to which the writer takes exception. It seems to me that both Prof. Thompson and the writer are wrong in this matter, if I understand them both. Prof. Thompson is right, and the writer is wrong, in regard to the moment of inertia of bodies at different distances from the axis; the moments of inertia of the same body at different distances from the axis are as the squares of the distances, but both Prof Thompson and the writer are wrong in supposing that the moment of inertia of a body has anything to do with the balance of the body, either statically or dynamically, except when the body has an increasing or diminishing velocity. If the body be rotating with uniform velocity, the moment of inertia has nothing whatever to do with its balance. The writer is correct in saying that a rotating body balanced dynamically is balanced statically, always supposing the motion uniform; but the converse of this proposition is not necessarily true. A body balanced statically is not necessarily balanced dynamically; but it is not for the reason that Professor Thompson states, but for an entirely different one. To illustrate: Suppose a long cylinder made up of thin discs; suppose that one of the end discs is heavy on one side of the axis and all the others are exactly balanced; if this cylinder be placed upon straight edges it will of course appear out of balance in consequence of the error in that one disc; there is nothing, however, in the action of the cylinder on the straight edges to indicate which of the discs is out of balance, and suppose that the workman, in order to balance it, places a counter weight at the opposite end of the cylinder from the disc that is the cause of the trouble. Then, when the cylinder is made to rotate, it will appear more out of balance than before. In other words, to obtain a perfect running balance, the cylinder should be in exact equilibrium in every plane perpendicular to the axis. And this is a most important point to be considered in the balancing of the armatures of dynamos. I saw not long ago an attempt made to balance a dynamo armature by putting a counter weight in the pulley at the end of the armature shaft. The effect was to make the jar due to the running of the machine greater than before, very much to the surprise of the workman who balanced it. The cause of the want of balance may have been at the further end of the armature from the pulley. I have been led to write you in regard to this matter because I have found in actual practice that very few men understand the necessity of determining where a balance weight should be applied in order to give a correct running balance. In balancing pulleys that are usually very short in comparison with their diameters, a good result generally follows from placing the counter weight anywhere opposite the heavy side, as indicated by balancing the pulley on straight edges. But in balancing a cylinder like the armature of a dynamo, the problem becomes a great deal more difficult one, and it is necessary to determine not only on which side of the axis the counter weight must be placed, but in what part of the length of the armature."

LEGAL INTELLIGENCE.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY LIMITED, v. HOLLAND AND OTHERS.

Mr. Justice Kay, in the High Court of Justice (Chancery Division), on Monday, delivered judgment in this action, which is one of the highest importance on the subject of electric lighting patents. The trial occupied the time of the Court for no less than 21 days, his Lordship reserving judgment at the conclusion of the arguments. The action was by the plaintiff company to restrain an alleged infringements of their patents by the defendants, Mr. William Holland, late manager of the Albert Palace, Battersea (where incandescent lamps had been used which, it was said, were substantially the same as those protected by the plaintiffs' patents), the Jablochkoff and General Electricity Company, Limited, who had supplied the lamps used at the Palace, and the Anglo-American Brush Electric Light Corporation, Limited, who were the manufacturers of them and had entered into an agreement with the Jablochkoff Company to indemnify them against the litigation. The patents upon which the plaintiffs sued are the same as those they succeeded in maintaining in the Court of Appeal last year, in two actions by them against Messrs. Woodhouse and Rawson—namely, the Edison patent, No. 4,576, of 1879, for the incandescent lamp, and the Chesebrough patent, No. 4,874, of 1878, for a mode of making uniform the carbon filament or thread which forms the light-giving portion of the lamp. The cases against Messrs. Woodhouse and Rawson will be found reported in the *Times* of May 23, 1886, and February 13, 1887; also in the *Times* Law Reports, Vol. II., pp 654—656; and Vol. III., pp. 327, 367. During the delivery of Mr. Justice Kay's judgment, which occupied nearly an hour and a quarter, the court was crowded to excess with persons of eminence in the scientific world, besides the general public. As will be seen from the judgment, his Lordship gave a highly interesting account of the processes in the gradual development of the incandescent lamp, a method of electric lighting now in use in the Royal Courts of Justice, and numerous other public buildings.

The Attorney-General (Sir R. Webster, Q.C.), Mr. Aston, Q.C., Mr. Moulton, Q.C., and Mr. A. M. Bremner appeared for the plaintiffs; and Sir Horace Davey, Q.C., Mr. Finlay, Q.C., and Mr. J. C. Graham for the defendants.

Mr. Justice Kay said: The plaintiffs sue the defendants for infringing two letters patent; one Edison's patent, No. 4,576, of November 10, 1879; the other, Chesebrough's patent, No. 4,874, of 1878, amended by disclaimer dated the 12th of November, 1884. Both patents relate to electric incandescent lamps. The defence is taken up

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by third parties, the Anglo-American Brush Electric Light Corporation. The validity of both patents is put in issue. The first thing necessary is to ascertain, as accurately as is possible, to anyone who has not had the necessary scientific training, what was known on the subject at the date of these patents, say, in 1879. There are two commonly known systems of electric lighting—the arc and incandescent systems. These patents relate to the latter. The former depended upon a break in the conducting material occurring at a point where the conductor was carbon in the form of a pretty thick pencil. The current leaped over the break in an arc, gradually destroying the carbons; and this arc gave a vivid white light, especially at the positive pole. The incandescent system is different. The conducting material in this is continuous, without any break or actual interval; but, being in part an imperfect conductor, that part becomes heated to its resistance to what is called the passage of the current, and this heating, raised to an intense degree, gives the light now familiar to us in the incandescent lamp. The material which is now so heated is some form of carbon. It was well known that this was a good material for the purpose, because it was an imperfect conductor—in other words, had a high specific resistance—and that it was essential to use it in a vacuum or in some gas or vapour which did not contain oxygen, otherwise the carbon consumed quickly. Until 1872, when Sprengel's air-pump was improved by Mr. Crookes, it was difficult to obtain a vacuum which was complete enough. The consequence was that it was necessary to employ a pencil of carbon of comparative thickness, because there was enough oxygen left within the exhausted glass bulb to occasion some consumption of the enclosed carbon, and also enough air to diminish the bulk of the carbon when incandescent by frictional action upon its heated surface, which Edison in his specification and some of the witnesses have called "air-washing." Another difficulty which prevented the use of very slender carbons was the irregularity of the current obtained from the dynamo. It was subject to variations, which at times produced a current stronger than the carbon could bear. This was remedied by the improvements of Gramme and Brush, which were perfected in the year 1878. Two modes of improving the resistance of the carbon were known, one by increasing its length, the other by the diminution of its thickness—or, to use the more exact language of the witnesses, of its sectional area. It was known that the carbon for an incandescent lamp must be enclosed in a glass bulb from which the air must be exhausted. Bulbs made entirely of glass had been used and publicly exhibited for this purpose. It was known that molten glass could be made to adhere closely to platinum wires, because the glass proper for the purpose expands with heat in the same degree as that metal, and that for this reason and also because of its properties as a conductor of electricity, the best mode of connecting the carbon within the glass bulb with the main wires through which the current passed, was to unite each end of it to a thin platinum wire, and to fuse the glass round these wires so that air should not penetrate at the points at which they entered the bulb. It was known that by increasing the electromotive force the main wires bringing the electric current to the lamps might be reduced in size, just—to take the illustration given by Sir F. Bramwell—as by increasing the hydraulic pressure in the pipes supplying a town with water, you are enabled to use smaller pipes, because the water will pass with accelerated velocity. It was known that by using high resistance in the incandescent portion of the lamp smaller leading wires might be employed, and also a greater number of lamps might be illuminated from the same source of electricity by working them, as Dr. Hopkinson calls it, in multiple-arc or in parallel. Two systems of using incandescent lamps were known, and it was recognised that when many lamps were to be lighted from one central station, and at some distance, the system called "multiple-arc" or "in parallel" was best. That may be shortly described as a plan involving the use of one main leading and one return wire, each lamp being supplied with electric current by a smaller wire from the main leading wire, and returning such portion of the current as it took to the return wire, the main leading wire and the return wire being supposed to be parallel. The other system, which is little employed, was the use of lamps "in series." In this case the whole current is sent through each lamp in succession, and accordingly lamps of comparatively low resistance are required. The *desideratum* in 1879 was to obtain lamps of high resistance for the "multiple-arc" system, which could be made "commercially," that is, in large quantities with reasonable cheapness, and, above all, that should have durability. Edison, Lane Fox, Swan, and others had been working with this object in the same direction. On the 19th of December, 1878, in a lecture given by Swan at Newcastle, he described an experiment on the production of light by passing a current of electricity from a dynamo through a slender rod of carbon enclosed in an exhausted globe. On January 17, 1879, he lectured on the same subject at Sunderland, illustrating his lecture by experiments, exhibiting certain electric lamps. On the 4th of February, 1879, he again lectured at Newcastle, and he then exhibited the lamp which has been produced in evidence. It consists of a bulb made entirely of glass with leading platinum wires sealed into it, and connected with a pencil of carbon inside the bulb. This piece of carbon was obtained from Carré, of Paris, and was manufactured by him and shaped before being carbonised. It is 1-25th of an inch in diameter—that is, considerably thicker than the carbons now used—and, being straight, the leading wires are sealed into the bulb at opposite ends. This renders it liable to a defect which is alluded to in the correspondence between Swan and Mr. Stearn—viz., rupture of the carbon, or its separation from the wires by expansion and contraction under the great heat to which it is exposed. This lamp was exhibited again at Gateshead on the 13th of March, 1879, and seems to have been kept lighted for ten to twenty minutes at a time on two or three occasions without injury. I have no evidence how long it would last if continuously used. Swan, in the spring of 1979, ordered from Carré carbons in the shape of a hair-pin, a model of which he produces. It is practically identical in form with some of the carbons now used in lamps, but with a larger sectional area. Lamps made with these would not have the defect to which I have alluded. He says that probably towards the end of 1879 he made some lamps with those hair-pin carbons. They are referred to by Mr. Stearn in a letter dated the 26th of November, 1879, in which Fig. 2 is a sketch of a lamp so mounted, but I do not lay much stress upon this as an anticipation of Edison, for, although Heaviside and other witnesses speak of having seen these lamps in 1879, I think the fair result of this evidence is that these were experiments which did not succeed in producing a commercially successful result before Edison's patent. On the 2nd of January, 1880, Swan obtained a patent for one of the most valuable inventions connected with the manufacture of incandescent lamps. That was for preparing the carbon by passing the electric current through it, and heating it to incandescence while the bulb was still connected with a Sprengel air-pump in action. This is now always done, and the effect is to make the vacuum much more perfect, or, rather, less liable to be impaired by air or gas coming from the carbon itself when first heated in a vacuum. On the 21st of January, 1880, he obtained a patent for a horse-shoe strip of cardboard prepared for an incandescent lamp by converting it into a substance like parchment by treatment with sulphuric acid and then carbonising. On the 27th November, 1880, he obtained a further patent for the application of this process to cotton thread. This has proved a most valuable invention. It produces a non-structural tough material, said by one of the witnesses to be hard and stiff as a metallic wire, and this is now largely used for incandescent lamps. Mr. Edison applied to the object of producing a lamp of high resistance his untiring and apparently inexhaustible ingenuity; but his specification shows—as Sir F. Bramwell states—that he was not aware how much was actually then known to electricians like Lane Fox and Swan, and Edison conceived that he was the first inventor of some matters in which they seem to have anticipated him. Edison availed himself of the more perfect vacuum obtained by the Sprengel pump, and also of the known principle of increasing the resistance of the carbon by diminishing its sectional area, which had become possible to a much greater degree owing to the perfecting of the Sprengel air-pump and the dynamo. The most important point raised upon the construction of his patent of November 10, 1879, is the extent of the second claim—whether it includes every lamp of the kind there described, the light-giving carbon in which is a "filament"; or whether it means only lamps with such filaments as are particularly mentioned in the body of the specification. Another point is upon the first claim, whether the word "lamp" in that claim does not mean merely the filament of carbon. A third question of construction is whether the carbonisation of the filament is to be effected before or after it is attached to the platinum wires. With respect to the sufficiency of this specification, it is urged that Edison ought to have defined exactly what was meant by the word "filament," and that his patent of 1879 is void for insufficiency of specification in this respect, and also because it does not give sufficient directions for carbonising filaments. None of the modes of making filaments particularly described, it is said, are practical; or, at any rate, some are not, especially the several modes of making filaments from a putty composed of lamp-black and tar, and from that putty compounded or coated with various substances. Also, if the patent means that the filament is to be carbonised after being attached to platinum wires, this, it is said, is impracticable because the platinum wires would thereby be made porous and brittle, and could not be sealed into the glass so as to prevent air getting in at the point of sealing, or through the pores in the wire. His Lordship then referred to "Neilson v. Harford" (8 "M. and W.," 806) and "Simpson v. Holliday" (13 "W. R.," 578, "L. R." 1, H. L., 315) as to the proper mode of construing a specification, and proceeded: With regard to the construction of Edison's patent, No. 4,576 of 1879, I observe, first of all, that the provisional specification begins by stating the necessity that lamps connected in multiple should be employed without main wires of great size, and that it is essential that these lamps should have a high resistance. It is stated that this had been set forth in a previous patent of Edison's of the same year, and that lamps of great resistance had been obtained by a long wire of platinum or other metal pyro-insulated (which means coated with an incombustible substance) and coiled so that but small radiating surface was exposed. Then it is said that the present invention relates to lamps of a similar character, except that carbon threads or strips are used in place of metallic wire, and connected to platinum wires sealed into a bulb exhausted of air. A description of the mode of manufacture is then given, but not in so much detail as in the complete specification. Turning to that, I find that it commences with a short statement that the object of the invention is to produce incandescent lamps of high resistance. Then follow four paragraphs stating in what the invention consists. The first of these is the coiling of carbon wire or sheets so as to offer great resistance and present but a slight surface for radiation. The next the placing of such light-giving body of great resistance in a nearly perfect vacuum. The third states that the connecting wires are platinum sealed into the glass. The fourth is the method of manufacturing carbon conductors of high resistance, and securing perfect contact between them and the wires. The specification next states Mr. Edison's view of what had been done up to that time. It is admitted that this is inaccurate in many respects. He appears to be have been unaware of the attempts that had been made to do the very thing at which he was aiming—that is, to increase the resistance of the carbon burners in lamps made of bulbs of glass exhausted of air, the connecting wires being made of platinum sealed into the glass. He seems ignorant that bulbs made entirely of glass had been used, or that they had been exhausted of air so as to form a vacuum. His Lordship then read Mr. Edison's description of the several modes of making the carbon burners, and proceeded: Then come the claims, which are four in number—"(1) an electric lamp for giving light by

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incandescence, consisting of a filament of carbon of high resistance made as described and secured to metallic wires as set forth; (2) the combination of a carbon filament within a receiver made entirely of glass through which the leading wires pass, and from which receiver the air is exhaused for the purposes set forth; (3) a coiled carbon filament, or strip, arranged in such a manner that only a portion of the surface of such carbon conductor shall radiate light as set forth; (4) the method herein described of securing the platina contact wires to the carbon filament and carbonising of the whole in a closed chamber substantially as set forth." I do not agree that the word "lamp" in the first claim means only the "filament of carbon." The claim is, "an electric lamp for giving light by incandescence," which the filament alone could not do. The words "consisting of" are inapt, but the wording of the whole specification is exceedingly inaccurate, and this is only an example of such inaccuracy. "Containing" would have been a better word. I construe this claim to mean lamps such as described in which the distinguishing features are carbons of "high resistance made as described and secured to metallic wires as set forth." After commenting on the other claims, his Lordship proceeded: The claims, as I read them, are—(2) a combination of four requisites for a lamp; (3) and (4) claims for two of those requisites separately; and (1) a claim for particular modes of making and attaching to platinum wires the first item of the combination—viz., the carbon filament. But claim (2) comprehends lamps containing carbon filaments, however made, and not only those made in the special modes described in the body of the specification and included in claim (1). The defendants construct incandescent lamps with all the four elements of the combination described in Edison's second claim. But the filament made by them is essentially different from anything particularly described in Edison's specification. His Lordship then described the defendants' mode of making the filament used by them, and continued: As I have come to the conclusion that Edison's second claim is wide enough to include any lamp wih a carbon filament, however made, the defendants have clearly infringed this claim. Then comes the serious and important question whether so wide a claim can be supported. I have already pointed out that the only item of the combination which had any novelty was the use of the filament or "very slender thread" of carbon. Edison had managed to use carbons thinner than anyone had used previously. The only advantage of a "filament" suggested in the specification is its high resistance by reason of its thinness or small sectional area. There was no invention described in this specification of any new principle. The principle of increasing resistance by diminishing the sectional area of the carbon was known and had been published by Lane Fox and by Swan before November, 1879. Assuming that Edison had been the first successfully to put that principle in practice by the methods described in his specification, did that success entitle him to say "no one shall make a lamp with a filament of carbon but myself?" Suppose the claim had been thus worded—"I have succeeded in making an electric lamp with a carbon burner, say, 1-00th of an inch in diameter, which gives a high resistance, and I claim a monopoly of all lamps with carbon burners but thicker than that, however made." Could such a claim be supported? That, in effect, is Edison's second claim. One of the objections made is that the claim ought to have been worded in some such ways as I have suggested in order to make it sufficiently definite. In other words, Edison ought to have indicated the exact boundary between his "filament" and such a Carré carbon as Swan had successfully used. From the drawings, and from the great stress laid upon coiling the filament, the only object of which seems to be to increase resistance by using a considerable length, I should conclude that Mr. Edison did not conceive that extreme thinness of the carbon was practicable. Mr. Swan had tried paper, cardboard, and similar materials carbonised, and, if he had not tried a "filament," he had used and obtained considerable success with Carré carbons not more than 1-25th of an inch in diameter. He was trying these in the form of a hair-pin, made and shaped to that form before carbonisation; and it seems impossible to say that Edison, by reducing the thickness of the horse-shoe carbon, had made any vast invention or contributed largely to the knowledge which such inventors as Swan and Lane Fox already had on the subject. His Lordship then referred to "Jupe v. Pratt" (1 "Webst.," 146) as an authority on the right of an inventor to be protected on patenting a practical mode of applying a new principle discovered by him, and proceeded: But is there any decision that an inventor who has discovered a mode of applying a known principle like this—of increasing resistance by diminishing the sectional area of the carbon burner—can obtain a monopoly of the principle? Sir F. Bramwell, in his evidence for the plaintiff, put too case in the strongest and most favourable manner by saying that Edison made the first commercially successful incandescent lamp. Unless that is so, his claim to so large a monopoly would not, in my opinion, be arguable. I proceed to enquire—Did he make a commercially successful lamp—that is, were any of the modes of making lamps particularly described in the specification commercially successful. His Lordship then referred to the numerous other electric patents taken out by Edison, and proceeded: The plaintiffs have been challenged again and again during the cross-examination of their witnesses to prove, if they can, that any lamp with a burner made according to the description in the body of the specification of November, 1879, has been brought into the market in England or in America. No evidence of this has been given, and I conclude that there was no commercial use of the invention of that kind. Until he had taken out his subsequent patents it seems that Edison did not introduce any lamp to the public. His Lordship then referred to certain experiments which had been made in constructing lamps under the patent of 1879, and continued: With respect to the commercial success of the invention as tested by these experiments, I find from the report and a supplemental table of results, which has been handed to me as an agreed statement, that out of 100 lamps some broke down at once, 13 lasted less than 10 hours, 11 more less than 20, 18 more less than 40, and only six above 40 hours, of which four were unbroken at 60 hours, and of these four there is no further record. That is far from commercial success. No system of electric lighting could be maintained, except at an expense which could not practically be incurred, with lamps of such short life as these; and this explains most satisfactorily why Edison never sold lamps made according to the specification of 1879. In considering the sufficiency of this specification, it must be remembered that in 1879 there was no trade or business of manufacturing electric incandescent lamps. Lane Fox, Edison, Swan, and other inventors had given much time and attention to the subject, but except such persons there were none who had any special knowledge in the matter. The *dicta* that may be found in some cases that the specification of certain patents must be read as addressed to adepts in the particular trade or business do not apply. For this reason it was essential that the specification should be carefully explicit. It ought to be such as would enable an intelligent working man to make an incandescent lamp without having to try experiments. His Lordship then examined the specification on the question of sufficiency of description, and arrived at the conclusion that it was vague and insufficient. His Lordship then proceeded: My opinion is that the patent of Edison's, No. 4,576, of 1879, is invalid—first, because the second claim is for a monopoly of incandescent lamps containing a filament of carbon for a burner, which claim, I think, is far too wide, considering how little Edison had actually invented; secondly, because his specification does not describe a lamp which ever became, or, as I think, could have become, commercially successful; thirdly, because the directions therein contained are so insufficient that no one could have made the carbons he describes without considerable previous experiment; fourthly, because one of the processes described—namely, mixing the carbon with a volatile powder—I believe to be practically injurious, if done as Edison directs; fifthly, because the coating with a non-conducting, non-carbonising substance, if not injurious, is of no practical utility; sixthly, because the same may be said of coiling the filaments, on which the patentee lays great stress. This patent of Mr. Edison's, No. 4,576, of 1879, has been the subject of litigation in a previous suit between the present plaintiffs and Messrs. Woodhouse and Rawson, who were manufacturing incandescent lamps, and were sued by the plaintiffs for infringements. The case went to the Court of Appeal, and both in the Court of First Instance and in the Court of Appeal the patent was treated as valid, though apparently with some hesitation. I am bound by these decisions, and should follow them, of course, whether agreed with them or not, if the evidence in the two cases were the same. But that is not so. On one point, which Lord Justice Cotton seems to have thought essential, the Courts were completely misled. They were given to understand that the carbon-burner in the lamp exhibited by Swan before the date of Edison's patent was shaped after, and not before, carbonisation. It is now admitted this was not the fact. It was a carbon made by Carré, and used as made by him without alteration. But, further, I am told that there was no evidence in that case as to the difficulty of making the carbon described in Edison's patent from the description in the specification. I understand that no contest took place as to the sufficiency or utility of any part of Edison's patent, and that nothing like the evidence as to the previous knowledge on the subject was given in the trial which has been adduced in this. With respect to the construction of the patent, the opinion which I have expressed agrees with that of the majority of the learned judges in the Woodhouse and Rawson trial. The case has been brought before me with such an elaboration of evidence on every point that I think myself bound to act upon my own opinion, believing as I do that if the same materials had been before the learned judges in the other case they would have arrived at the same conclusion as I had done. The other patent in question in this action is Chesebrough's, No. 4,874, of 1878, amended by disclaimer dated November 12, 1884. The specification describes and claims a method of preparing the illuminating portion of an electric lamp, and also a material for the manufacture of illuminating carbons. Shortly stated, the carbon to be prepared is surrounded with a carbon gas or liquid and then heated intensely by the passage of the electric current. This causes a decomposition of the surrounding hydrocarbon, and the deposit upon the heated surface of an extremely dense form of carbon, such deposit being in greater quantity upon the hotter—that is, the thinner—portion. The specification states that "carbon of the ordinary sort when heated by the electric current, exhibits points and lines of unequal brilliancy. Carbons prepared by the process when so heated glow with a uniform brilliancy throughout." A French chemist, Despretz, in experimenting on the reduction and volatilisation of carbon, discovered that when the carbon was heated in an atmosphere of hydrocarbon this deposit occurred and interfered with his operations; and he describes this in a paper which was published in England some years before 1879. But Despretz did not utilise this product in any way, and his experiments had nothing to do with electric lighting. Assuming that Chesebrough derived his knowledge of the mode of producing this material from Despretz's paper, his invention consists in applying it for the purpose of making uniform the light-giving power of a piece of carbon when heated by the electric current; and the beauty and merit of the invention consist in thus enabling an imperfect carbon, by a sort of automatic operation, to improve and perfect itself. I have no doubt that this is a good subject for a patent. I had more hesitation upon the claim for the material, which certainly was not discovered by him; but that is not the whole of the claim. It is for "a material for the manufacture of the illuminating conductors of electric lamps produced by electricity heating carbon in the carbon gas." That does not prevent anyone from making the same material and using it for other purposes. The claim is really for the use of the material for the burner of an electric lamp. This seems to me equally valid. Another objection—that pencils cut from the lime cylinder coated with carbon would not make effective carbons—seems to me to arise from a misconstruction of the specification. It is not the lime cylinder, but the deposit of carbon which is to be made in burners. The defendants have used this process at Chesebrough's, but they say for a different purpose.

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The object is to bring all their carbons to one standard of illuminating power, an operation for which they have invented a somewhat cacophonous word—"standardising." But Sellon, one of their principal witnesses, admitted that the process would cure any inequalities of light-giving surface in the particular carbon so treated. These, he says, in their cellulous carbon threads seldom occur However, I cannot resist the conclusion that the defendants, by this use of the process for carbons of incandescent lamps, are infringing Chesebrough's patent. The plaintiffs' reply in this case was, unfortunately, interrupted. The Attorney-General asked leave, if the Court wanted more assistance on any point, to add somewhat to the reply. I have not thought it right to trouble him further. Every point has been put again and again to the scientific witnesses. Twenty-one of the working days of the Court have been occupied by this case. I have not arrived at the conclusion I have intimated without thought and care, and I do not think that further argument would be a useful expenditure of public time. I must, therefore, decline to trouble counsel any more in the case. I have been provided with a copy of the print of the shorthand notes. They contain, as is, perhaps, inevitable in such a case, a considerable number of verbal inaccuracies, some of which completely distort the meaning of what was said. The action, so far as it relates to Edison's patent of 1879, must be dismissed with costs. There must be an injunction to prevent any further infringement of Chesebrough's patent, and the defendants must pay the costs of the action so far as it relates to that. The costs must be set off in the usual way.—*The Times.*

THE UNITED TELEPHONE COMPANY v. TASKER, SON, AND CO.

This was an appeal, before Lords Justices Cotton, Fry, and Lopes, against a decision of Mr. Justice Kay. The defendants are the proprietors of a telephone exchange at Sheffield, and the action was brought to restrain the defendants from infringing a patent (known as the Bell patent) for telephones, granted in 1876 to the plaintiffs' predecessors in title. The plaintiffs moved for an interim injunction. The defendants admitted that they were using telephones which were an infringement of the plaintiffs' patent, but they justified their conduct in the following way. They said that they had formed an exchange in Sheffield; that they had done this at the invitation of the plaintiffs' predecessors in title, and under an agreement subject to which the patent was transferred to the plaintiffs. The plaintiffs now refused to carry out the agreement, and refused to supply the defendants with telephones at all; so the defendants made telephones, which they admitted were an infringement of the plaintiffs' patent. Mr. Justice Kay (as reported in *The Times* of the 9th June) said that the defendants, by their conduct, were taking the law into their own hands; because the contract had been broken they took upon themselves to infringe the patent. Their defence was no justification of the infringement; but, at the same time, it was suggested that the contract under which the exchange in Sheffield was formed had been broken by the plaintiffs in a flagrant manner, though that was denied by the plaintiffs. His Lordship granted an injunction until the trial, or further order, to restrain the defendants, their servants, and agents, from making, using, selling, or otherwise disposing of any telephones which were an infringement of the plaintiffs' patent, on the plaintiffs undertaking to supply to the defendants upon the usual terms as to cost, either by way of loan, sale or letting for hire, at their pleasure, so many telephones as the order would prevent the defendants from using, the plaintiffs also giving the usual undertaking in damages. The plaintiffs assented to the giving of this undertaking. On the hearing of the motion it was stated that the defendants were using 52 telephones, which were infringements of the patent. Before the drawing-up of the order was completed, the defendants informed the plaintiffs that they had discovered that they had in use 44 other telephones, which they had purchased from one Paterson, on a representation and a guarantee by him that these telephones had been made under a license from the plaintiffs, and that they had discovered that no license had, in fact, been given. The defendants contended that the plaintiffs' undertaking extended to the forty-four telephones, as well as to the fifty-two. The plaintiffs objected to this, and applied to Mr. Justice Kay to be relieved from their undertaking. Mr. Justice Kay held that the undertaking ought to extend as the defendants desired, and declined to relieve the plaintiffs from their undertaking, except on the terms of discharging the injunction altogether. The plaintiffs appealed.

The Attorney-General (Sir R. E. Webster, Q.C.), **Mr. Aston, Q.C.**, and **Mr. Micklem** (with whom was Mr. Moulton, Q.C.), for the plaintiffs, contended that the plaintiffs were entitled to an injunction in general terms; but said that they were willing to give the undertaking if limited to the fifty-two telephones.

Mr. Ince, Q.C., and **Mr. W. R. Bousfield**, for the defendants, were content to accept the undertaking thus limited; but they said that the defendants never pretended that they had only fifty-two instruments in use—they had from 1,200 to 1,500 in use, and the plaintiffs had alleged that 200 of these were infringements of the patent. The defendants only intended to say that they had fifty-two infringing instruments in use, and they made that statement honestly, and did not discover until after the hearing of the motion that the other forty-four telephones were also infringements, when they at once communicated with the plaintiffs.

The Court allowed the appeal.

Lord Justice Cotton was satisfied that, though the undertaking was given in general terms, it was given upon the understanding of both parties that only 52 telephones which were infringements of the patent were in use by the defendants, to which 52 the undertaking and the injunction would apply. As soon as the blunder was discovered the defendants ought to have consented to a limitation of the undertaking to the 52 telephones, and his Lordship thought that Mr. Justice Kay ought to have been satisfied on the evidence before him that the undertaking had been given by the plaintiffs as applying only to the 52 telephones, and he should have limited the undertaking accordingly. That, his Lordship thought, was the undertaking which the plaintiffs intended to give. He did not say that the plaintiffs were bound to give any undertaking, but they were willing to do so, and they had a right to have the undertaking limited to that which they intended to give. With regard to costs the defendants had made a mistake as to the number of infringing instruments which they were using, and, as soon as they found it out, they ought to have acceded to the plaintiff's desire that the undertaking should be limited to that which they intended to give, and ought not to have compelled the plaintiffs to apply to Mr. Justice Kay. The costs, therefore, of that application and of the appeal must be the plaintiffs in any event.

Lord Justice Fry did not doubt that the mistatement of fact was a bona fide error on the part of the defendants, or that there was no intention to deceive. But when the error was discovered the defendants ought to have assented to confining the undertakings of the 52 instruments which were in the mind of the plaintiffs when they agreed to give the undertaking.

Lord Justice Lopes concurred.

COMPANIES' MEETINGS.

WEST AFRICAN TELEGRAPH COMPANY.

The third ordinary general meeting of the West African Telegraph Company, Limited, was held on Friday last, at the offices, Cannon-street.

Major-General Sir F. J. Goldsmid, C.B., who presided, said that the traffic had not increased to the extent they would have been glad to see, but in other respects he thought they would find that the working had been satisfactory, and the whole line was at that moment in good order and condition. It was stated at the last meeting that there had been some difficulties in the way of realising the subsidy and guarantees until the accounts were placed on a clear footing. Since then the French subsidy had been paid up to the end of 1887, and the Portuguese guarantee had been paid up to the end of September last. There was, therefore, every reason to suppose that those payments now would be regular. With reference to the traffic, statistics for the complete line were available from September, 1886, but it would hardly be fair to compare the first three months' working of the complete line with the corresponding period in 1887. Taking, however, the first five months of the present year, and comparing the number of words with that of the corresponding period of 1887, after making due allowance for the loss resulting from the interruption on the St. Thomé-Loanda section, they might fairly consider that the volume of traffic had increased at least 15 per cent. For the present they must rely on their guarantee and subsidy, hoping for better results in the future, when the system was connected with the Cape; and Mr. Matthew Gray, of the Indiarubber, Guttapercha, and Telegraph Works Company, had sent him a letter stating that that Company was working earnestly towards completing the section from Loanda to the Cape, and that they had every hope that the connection would be made by the end of the year. He concluded by moving the adoption of the report and the payment of a dividend of 3s. a share.

Sir Henry C. Mance seconded the motion, which was unanimously adopted.

The appointment of Mr. E. March Webb as a member of the Board was confirmed, and the retiring Director and Auditors were re-elected.

At an extraordinary meeting held afterwards a resolution was passed correcting an error in the articles of association.

WESTERN COUNTIES AND SOUTH WALES TELEPHONE COMPANY.

An adjourned meeting of the shareholders of the above Company was held on Thursday, July 12, at the Royal Hotel, College Green, Bristol, for the purpose of sanctioning the raising of additional capital to enable the Company to carry out contemplated extensions. Mr. Charles Nash presided.

Mr. H. F. Lewis, secretary and general manager, having read the notice convening the meeting,

The **Chairman** said it had been thought desirable to defer the arrangement for issuing a further amount of share capital, so that the first resolution attached to the report was withdrawn, and he now moved the second resolution, which was as follows:—"That the articles of association be altered in manner following—that is to say: (A) The following article shall be substituted for Article 71—namely, 'They may borrow any sum or sums of money on such security and terms as to interest, or otherwise, as they may deem fit, and may secure the same by mortgage or other debentures, or by bonds or other securities, or by any mortgage or charge of, or upon, the whole or any part of any property, funds, assets, or effects of the Company, or its uncalled capital; but so that not more than £20,000 be owing at any time without the consent of a general meeting, and provided that no part of the said sum of £20,000 shall be borrowed without the consent of the United Telephone Company, Limited, and no borrowed money shall, without the like consent, carry interest at a higher rate than 6 per cent. per annum.' (B) In Article 91 the word 'and' coming after the word 'agencies' shall be omitted, and the words 'trunk lines and new business' shall be inserted after the word 'branches.' The clause as amended shall apply as from the formation of the Company." The sum mentioned (the Chairman continued) might be sufficient to carry them through the present year, and they hoped that money would be obtained at a

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lower rate of interest than if share capital had been offered—probably not exceeding 5 per cent. He would just repeat what he thought he said at the last meeting—viz., that it was necessary they should have further capital in hand to enable them promptly to cover some further portion of the large district which formed the territory of the Company. It would be their duty very carefully to select from the long list of places mentioned in the report those that were likely to give them a speedy return, and to arrange for opening exchanges in them, and also for connecting them, where desirable, by trunk lines. The only other point, he thought, was that it would not be necessary to borrow the whole of this money at once. That would be done at intervals as required. The last clause of the resolution was only inserted for the purpose of removing ambiguity and making the meaning of the clause plain. There had been a doubt as to whether it included trunk lines or not, and there would be no doubt about it any longer, as these words made the matter perfectly plain. He would only add that the general progress of the company continued to be very satisfactory, and that from week to week they were getting considerable accessions of business. Since they last met there were two places where arrangements were now in progress for speedily opening exchanges — he referred to Cheltenham and Swindon. Perhaps they might not be very valuable in themselves, but Cheltenham, when connected with Gloucester and the Stroud district, and Swindon, if connected with Bath and Bristol, would, he believed, bring a very considerable increase to their business.

Mr. Mark Whitwill seconded the motion, which was carried unanimously.

The **Chairman** said he should like to supply an omission he made at the annual meeting in June by expressing what he was sure was the feeling of the Directors, their high appreciation of the great energy and ability of Mr. Lewis, the general manager. During some very heavy work that had been going on lately, Mr. Lewis had been very ably supported by the members of the staff. They had often had to work long hours. That they had done willingly, and he thought it was only due to them that it should be mentioned.

Mr. Henry Fedden said he had seen a great deal of Mr. Lewis's work and would like to confirm what the Chairman had said in regard to it. He never knew a man who was more earnest in his work than Mr. Lewis, who had shown a thorough determination to make the Company a success.

Commander D. M. Forsyth, R.N., also testified to the great help which Mr Lewis had rendered, both in the formation of the Company and in its subsequent development.

Mr. Lewis briefly returned thanks and the meeting terminated.

NEW COMPANIES REGISTERED.

The Barnoldswick Gas and Light Company, Limited.—Registered by Waterlow Brothers and Layton, Birchin-lane, E.C., with a capital of £12,000, in shares of £10 each. Object: To adopt and carry into effect an agreement, dated May 9, 1888, and made between Christopher George Bracewell Smith Smith and Joseph Henry Threlfull of the one part, and George Kendall of the other part. To manufacture, sell, and supply gas and any other illuminating power in the parish of Barnoldswick, in the county of York, and generally to carry on the business of gas manufacturers and gas fillers, electrical engineers, and every other business in any way connected with the manufacture and sale of gas and electricity or other illuminants. The first subscribers are:—

	Shares.
H. Slater, manufacturer, Barnoldswick	120
J. Pickup, general dealer, Barnoldswick	50
J. Broughton, mason, Barnoldswick	40
J. D. Roberts, physician, Barnoldswick	40
S. Slater, porkbutcher, Barnoldswick	60
C. Brookes, grocer, Barnoldswick	15
J. Hartley, innkeeper, Barnoldswick	20

The number and names of Directors shall be determined by the subscribers to the memorandum of association. The remuneration of Directors shall be determined in general meeting.

The East Strand and District Electric Light and Power Company, Limited.—Registered by the Land Company, Limited, with a capital of £5,000, in shares of £5 each. Object: to apply and obtain, either singly or jointly, licenses, provisional orders, or Acts of Parliament for the supply of electricity; to establish and carry on the business of suppliers of electric energy, of manufacturers of and dealers in electrical apparatus and appliances of all descriptions used or intended to be used in any way in, or which are applicable to, the generation, distribution, storage, measurement, conversion or utilisation of electricity, and the business of an electric light and power company in all its branches, and of engineers and contractors, and such other business as the Directors of the Company for the time being may consider desirable for the interest of the Company. The first subscribers are:

	Shares.
J. Dunn, F.R.I.B.A., 1, John-street, S.W.	1
C. E. Lloyd, 4, King's Bench-walk, E.C.	1
A. W. Lightbody, 222, Strand, W.C.	1
S. H. Burbury, 1, New-square, Lincoln's-inn, W.C.	1
E. Wilson, 5, Adam's-court, New Broad-street, E.C.	1
A. M. Lloyd, Norfolk House, Victoria Embankment, W.C.	1
J. G. Lorrain, M.I.M.E., Norfolk House, Victoria Embankment, W.C.	1

The company is registered without articles of association, and consequently the regulations of Table A of the Companies Act of 1862 apply.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ending July 13 amounted to £4,582.

West African Telegraph Company.—The West African Telegraph Company, Limited, announce a dividend of 3s. per share, payable at the National Bank of Scotland, Nicholas-lane.

Indiarubber, Guttapercha, and Telegraph Works Company.—The Directors of the Indiarubber, Guttapercha, and Telegraph Works Company, Limited, recommend an interim dividend of 5 per cent., or 10s. per share, tax free.

West India and Panama Telegraph Company.—The estimated traffic receipts of the West India and Panama Telegraph Company for the half-month ending July 15 were £2,525, against £2,398 in the corresponding period of 1887.

Western Brazilian Telegraph Company.—The traffic receipts of the Western Brazilian Telegraph Company, Limited, for the week ended July 13, after deducting the "fifth" of the gross receipts payable to the London-Platino Brazilian Telegraph Company, Limited, were £3,789.

Anglo-American Telegraph Company.—At a meeting of the Board of Directors of the Anglo-American Telegraph Company it was resolved to declare an interim dividend for the quarter ended June 30 of 5s. per cent. on the ordinary stock, and 10s. per cent, on the preferred stock, less income-tax, payable on August 1 to the stockholders registered on the books of the Company July 10, 1888.

Globe Telegraph and Trust Company.—The Directors of the Globe Telegraph and Trust Company have declared a final dividend of 3s. per share, less income-tax, on the preference shares, and of 3s. per share on the ordinary shares, free of income-tax, making, with the previous payments, a dividend for the year of 6 per cent. on the preference shares, and 3½ per cent. on the ordinary shares.

Bankruptcy.—A meeting of the creditors of Luther Hanson, electrical engineer, Halifax, has been held at the offices of the Official Receiver. The debtor's statement of affairs showed assets £1,724. 17s. 4d., and liabilities £4,518. 3s. 8d., a surplus of £206. 13s. 8d. In this estimate, however, the works had been taken as a going concern. The debtor was made bankrupt, no offer of composition being made. Mr. James Duff, of Barum Top, was appointed trustee, with a commitee of inspection.

Direct United States Cable Company.—The report of the Direct United States Cable Company, Limited, for the six months ended June 30, shows that the revenue (still subject to revision), including income-tax refunded, and after deducting out-payments, amounted to £17,507, against £23,571. The working and other expenses for the same period, including income-tax, but exclusive of cost of repairs of cable, amounted to £15,276, leaving £2,231 as the net profit of the half-year, making, with £9,911 transferred from the reserve fund account, a total of £12,142. Three quarterly interim dividends of 2s. each per share, amounting to £18,213, have been declared and paid during the financial year, and a final payment of 2s. per share is proposed, making 2 per cent. for the year, being a total distribution of £24,284.

Anglo-American Telegraph Company.—The report of the Directors of the Anglo-American Telegraph Company, Limited, to be presented to the ordinary general half-yearly meeting of the proprietors, to be held on Thursday, July 26, at 12 noon precisely, shows that the total receipts from January 1 to June 30, including the estimated balance of £2,345 brought forward from the last account, are estimated at £77,579. This amount, however, is subject to revision, dependent upon the result of the lawsuit still pending between this Company and the Paris and New York Telegraph Company. The traffic receipts show a decrease, as compared with the corresponding period of last year, of £19,635. The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amounted to £42,189. One quarterly interim dividend of 5s. per cent. on the ordinary stock, and of 10s. per cent. on the preferred stock, was paid on the 1st of May, absorbing £17,500, and a second quarterly dividend of 5s. per cent. on the ordinary stock and 10s. per cent. on the preferred stock will be paid on the 1st of August, absorbing £17,500, leaving a balance of £390 to be carried forward to the next account.

Eastern Telegraph Company.—The report of the Directors of the Eastern Telegraph Company, Limited, for the half-year ended March 31 states that the revenue amounted to £359,706, from which are deducted £87,134 for the ordinary expenses and £38,412 for expenditure relating to repairs, renewals, and laying of cables, &c. The available balance was £259,104, from which have been paid interest on debentures and debenture stock, dividend on preference shares, and an interim dividend of 1½ per cent. on the ordinary shares, leaving £161,384, from which £75,000 has been carried to general reserve. The Directors recommend a final dividend of 2s. 6d. per share and a bonus of 2s. per share, both payable on the 19th inst., making, with three previous payments on account, a total distribution of 12s. per share, or 6 per cent., for the year on the ordinary shares. The balance of £884 will be carried forward. With the object of providing a duplicate and alternative telegraphic service to the Cape, the Eastern and South African Telegraph Company (nearly all the shares of which belong to this Company) are making arrangements with the West African Telegraph Company, under which the existing line of cables along the West Coast of Africa (now terminating at Loanda) will be continued to Port Nolloth and the Cape of Good Hope. The new cables will be worked by the Company as part of the Eastern and South African Company's undertaking.

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PROVISIONAL PATENTS, 1888.

JULY 6.

9825. **Improvements relating to switches for electrical purposes.** William Mackie, Turk's Head-yard, Turnmill-street, E.C.

9844. **Improvements in the construction of steam boilers, or generators for the economical generation of steam, either with or without the aid of electricity or electrical heat.** Emma Naomi Barnard, 46, Southampton-buildings, Holborn.

9854. **Improvements in and connected with secondary batteries or electrical accumulators.** Lars Bristol, 70, Chancery-lane, London, W.C.

JULY 7.

9907. **An improvement in electric current and tension meters.** Michael von Dolivo-Dobrowolsky and The Company Allgemeine Elektricitätsgesellschaft, 47, Lincoln's-inn-fields, London, W.C.

9910. **Improvements in and relating to continuous current dynamo-electric machines.** Gisbert Kapp, 70, Market-street, Manchester.

JULY 9.

9926. **Improvements in and connected with ships' compasses.** Thomas Bassnett, 4, Clayton-square, Liverpool.

9927. **Improved electrical make-and-brake switch for charging circuits of secondary batteries, and automatic cut-outs for other circuits.** George Vaughan Fowler and Edward William Lancaster, trading as Fowler, Lancaster, and Co., Temple-chambers, Temple-avenue, London, E.C.

9928. **Improvements in electrical regulators and armatures for dynamo-electric machines and motors.** George Vaughan Fowler and Edward William Lancaster, trading as Fowler, Lancaster, and Co., and Ernest James Penn, Temple-chambers, Temple-avenue, Whitefriars, London, E.C.

9931. **Improvements in recording and repeating speech and and other sounds.** Alan Archibald Campbell Swinton, 75, Queen Victoria-street, London, E.C.

JULY 10.

9991. **Improvements in magneto-electric apparatus.** William Robert Lake, 45, Southampton-buildings, London, W.C. (Wm. Humans, United States.) (Complete specification.)

10,048. **Automatic arrangement for switching accumulators in or out of circuit.** Bernard Mervyn Drake and John Marshall Gorham, 28, Southampton-buildings, Chancery-lane, London, W.C.

10,053. **Improvements in or relating to marine compasses.** Wallace John Reynolds, 166, Fleet-street, London.

JULY 11.

10,088. **Improvements in and connected with primary batteries.** John Vaughan Sherrin, 77, Chancery-lane, London, W.C.

10,092. **Improvements in the means or apparatus for supplying electricity to tramcars or other vehicles.** Alexander Login Lineff, 169, Fleet-street, London.

10,093. **Improvements in magneto-electric calling or signalling mechanism used for telephonic or telegraphic purposes.** Joseph Slater Lewis, 53, Chancery-lane, London.

10,101. **Improvements in ships' compasses.** Joseph Von Peichl, 28, Southampton-buildings, Chancery-lane, London, W.C.

10,102. **Improvements in electric batteries.** William Robert Lake, 45, Southampton-buildings, London. (Lacombe and Co., France.)

10,107. **Improvements in casing used for electrical conductors.** Charles Scott Snell, Culver-park, Saltash, Cornwall.

COMPLETE SPECIFICATIONS ACCEPTED.

SEPTEMBER 7, 1887.

12,111. **Improvements in electric fuses for mines.** William Phillips Thompson, 6, Lord-street, Liverpool. (E. Dumas, Paris, agent for Messrs. Bickford Smith and Co., Cornwall.)

SEPTEMBER 8, 1887.

12,166. **Improved appliances for making and breaking and protecting an electric circuit.** Harold Kingcombe Read, 25, Macfarlane-road, Shepherd's Bush, W.

SEPTEMBER 12, 1887.

12,325. **Improvements in telephonic apparatus.** Wallace Fairweather, 62, St. Vincent-street, Glasgow. (The Western Electric Co., United States.)

MAY 29, 1888.

7805. **Improvements in the method of and apparatus for the production, transmission, and distribution of electric currents.** Herbert John Allis n, 52, Chancery-lane, London.) (Charles Edgar Fritts, United States.)

JUNE 5, 1888.

8223. **A magnetic separator for extracting ferruginous matters from ores and other material.** Alexander Henry Reed, Suffolk House, Laurence Pountney-hill, Cannon-street, Middlesex. (Gurdon Conkling, United States.)

JUNE 9, 1888.

8457. **Improvements in mechanical telephones.** Lemuel Mellett, 55 and 56, Chancery-lane, London.

JUNE 12, 1888.

8596. **Improvements in automatic telegraphy.** James Yate Johnson, 47, Lincoln-inn-fields, Middlesex. (Edward Jones Mallett, United States.)

SPECIFICATIONS PUBLISHED.

1887.

8641. **Supply of electricity for lighting, &c.** H. Edmunds. 1s. 1d.

8795. **Galvanometers.** W. E. Ayrton and J. Perry. 6d.

10,233. **Combined electrical vapour bath.** M. Maitland. 8d.

11,004. **Electrical propulsion of tramcars, &c.** M. H. Smith. 8d.

11,195. **Incandescence bodies for illuminating.** O. Imray. (Von Welsbach.) 6d.

16,473. **Electrical railway signalling device.** S. S. Bromhead. (Street.) 8d.

1888.

1932. **Electrical contact for switches.** F. H. Royce. 6d.

4673. **Dynamo electric machines, &c.** P. M. Justice. (Heisler.) 1s. 1d.

4964. **Transferring electric currents.** A. J. Boult. (Doubrava.) 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday.
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	2¾
12 Feb.	2/0	— fully paid	5	3¾
26 April	1%	Anglo-American	100	41¼
26 April	2%	— Pref.	100	66½
12 Feb., 85	5/0	— Def.	100	13⅜
28 June	3/0	Brazilian Submarine	10	12½
14 June	1/0	Con Telephone & Main	1	¾x
15 Feb.	8/0	Cuba	10	13½
28 July	10/0	— 10% Pref.	10	19½
28 Mar.	2/2½	Direct Spanish	9	3¾
28 Mar.	5/0	— 10% Pref.	10	9
28 Mar.	2/0	Direct United States	20	8⅝
12 April	2/6	Eastern	10	12¼
12 April	3/0	— 6% Pref.	10	15
1 Feb.	5%	— 5%, 1899	100	111
26 April	4%	— 4% Deb. Stock	100	106½
12 July	2/6	Eastern Extension, Australasia & China	10	12 1/16x
1 Feb.	6%	— 6% Deb., 1891	100	106
2 July	5%	— 5% Deb., 1900	100	103½
2 May	5%	— — 1890	100	103
2 July	5%	Eastern & S. African, 1900	100	106
28 Mar.	8/3	German Union	10	6⅛x
12 April	2/0	Globe Telegraph Trust	10	6⅜
12 April	3/0	— 6% Pref.	10	14¼
30 April	5/0	Great Northern	10	14⅛

Dividend.		Name.	Paid.	Price. Wednesday
1 Mar.	5%	Gt. Northern 5% Deb., '83.	100	108
29 Feb.	10/0	India Rubber, G. P. & Tel.	10	17½
11 May	37/6	Indo-European	25	38
30 May	3/0	London Platino-Brazilian	10	6¼
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	⅜
26 April	4/0	Reuter's	8	8
		Swan United	3½	2⅜
15 Feb.	15½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
29 Feb.	36/0	Telegraph Construction	12	40
3 Jan.	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½x
		West African	10	5¼
1 Mar.	5%	— 5% Debs.	100	95
12 July	4/0	West Coast of America	10	6¾
30 June	8%	— 8% Debs.	100	117
11 May	9/	Western and Brazilian	15	10
11 May	6/10½	— Preferred	7½	6 1/16
11 May	2/1½	— Deferred	7½	4
1 Feb.	6%	— 6% A	100	112
1 Feb.	6%	— 6% B	100	107¼
		West India and Panama	10	1
30 May	10/0	— 6% 1st Pref.	10	10⅞
13 May, '80		— 6% 2nd Pref.	10	7½
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	103

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NOTES.

Milan.—The local technical society intends to organise a permanent exhibition of electrical inventions for Milan.

The Clyde Defences.—It is stated that the Government have under consideration the erection of two large and powerful electric lights on the rock west of Kempock Point, Gourock.

Portugal.—According to the Lisbon papers, the Portuguese Government has given its consent to the scheme of lighting the town of Evora with electric light. The population of this town is about 25,000.

Edison's New Sensation.—Edison is credited with having another great discovery ready to startle the world. This is supposed to be the realisation of man's hitherto unsuccessful longing for aërial navigation.

Personal.—In our last issue we were a little premature in our statement relating to Mr. Reckenzaun and Messrs. Woodhouse and Rawson. The negotiations, which we understood to be completed, have since fallen through.

Burning Liquid Fuels.—A series of articles on the construction of furnaces for burning liquid fuels is being given in *The Engineer* at the present time, which may be interesting to electrical engineers, especially for working of large colonial installations.

Underground Mains at Work.—A central station on the Edison system is running at Columbus, Ohio, with 6,000 16 c.p. lamps, and also about 60 h.p. distributed for motors. The most noticeable feature is that the mains are laid on the underground system.

Gas or Electric Power.—The growth of the demand for small electro-motors in America is causing some anxiety to the gas companies. In the city of Boston it is estimated that these motors divert from the gas company the sale of 50,000,000ft. annually, an item which even a large company can ill afford to lose.

Poole.—An application has been made to the Town Council of Poole by the Electric Light Company for permission to erect iron standards in different parts of the borough for carrying electric light wires. The Council have not arrived at any decision, and the matter has been held over till next meeting.

Appeal Cases.—We are informed that instructions have been given by the Edison-Swan Company to appeal against the recent decision of Mr. Justice Kay, discussed in our issue of last week. We also understand that Messrs. Gaulard and Gibbs have determined to appeal against the decision of Mr. Justice Kekewich.

Thin Film Cut-Outs.—The Thomson-Houston Company, of U.S., have instituted proceedings against the parties operating the Heisler system of street lighting at Fishkill, N.Y., for infringement of their patent covering the film cut-outs, which can be ruptured by the high tension current in case of failure of lamps, for series incandescent lighting.

Domestic Magneto Bells.—A new system of magneto-electric bells for domestic and similar purposes has recently been designed by Mr. E. Cox Walker and Mr. A. A. Campbell Swinton, and will very shortly be introduced to public notice. The Equitable Telephone Association, of 75, Queen Victoria-street, E.C., will be the agents.

Madrid.—The Royal Opera House at Madrid is to be lighted by the Sociedad Matritense de Electrisedad. The installation will consist of 2,000 incandescent lamps, and four arc lamps for the exterior. The Government owns the theatre, and the contract is made so that after eight annual payments the installation becomes the property of the Government.

Extension of Telephone Service — The Western Counties and South Wales Telephone Company have decided to connect Bournemouth and Poole with Southampton, Portsmouth, Winchester, Gosport, Bishopstoke, and Christchurch at once. These increased facilities for inter-urban communication should lead to rapid increase of exchange subscribers.

Indian Telegraphs.—The Indo-European Government Telegraph Department has been absorbed by the Indian Government department, under Sir Albert Capel, and their offices at Parliament-street will be given up at the end of the year. Mr. Alfred Brasher, traffic manager, who has for many years translated and published the rules of the International Telegraph Congress, retires upon a pension.

Preserving Telegraph Poles.—Telegraph poles are preserved in Norway by making an augur hole about 2ft. from the ground, in which four or five ounces of sulphate of copper in coarse crystals are placed, and plugged in. The chemical is gradually absorbed by the wood, until its whole outer surface turns a greenish hue. The sulphate requires an occasional renewal, and is said to be a perfect preservative.

Valencia.—A central electric light and power station is to be erected by the proprietor of the gas works at Valencia, which will be one of the largest installations in Spain. It will consist of twelve boilers with sixteen dynamos driven direct, giving 1,200 16-c.p. lamps each. The most recent improvements will be adopted by the engineer, who has recently returned from a visit to England, France and Germany.

Use of Water-Power in the Tyrol.—The gas company at Innsbruck will shortly start a central station for the supply of 3,000 incandescent lamps. The power will be obtained from a waterfall, five miles from the town, and the current will be led by overhead wires to Zipernowski transformers situated at different parts of Innsbruck. The secondary mains will be underground. The installation is being constructed by Messrs. Ganz, of Buda-Pesth.

Wire Gauge Brushes.—A new kind of dynamo brush has been introduced by Messrs. Crompton, which is said to have proved itself very satisfactory. Wire gauge is taken, cut on the diagonal of the mesh, as it is termed "on the bias," laid together in strips and folded over once or twice, and soldered firmly down. The result is a compact, perfectly flexible brush with innumerable points of contact, which produce the nicest surface upon the commutators, wears extremely well, and reduces the sparking to an infinitesimal amount.

The Garden Roller.—At Messrs. Crompton's works, Chelmsford, is a garden-roller which is very useful in delicate testing operations. It seems an incompatible article for electrical testing, but on certain adjustments being made it was found that the spot of light from the reflecting galvanometer jumped about in a curious manner, and on search being rigorously instituted, it turned out to be the effect of

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the man rolling the lawn with the iron roller. A lad is now sent out to adjust the position of this roller, so as to get the best conditions for testing.

Electric Pumps in Japan.—The Sprague Company of America has received a report from Tokio, Japan, on the operation of the electric fire-pump sent for use in the Mikado's new palace. The trials that have been made yield results exceeding the most sanguine expectations. Although the pump is on a temporary foundation and has to draw its water 12 feet, it does much more than was claimed for it. So strong is the opinion in its favour among the officials of the household, that it is probable that five or six of these machines will be placed in the palace.

Edison's American Patents.—The Edison Electric Light Company of New York, having had the case decided against them by Judge Wallace on the issue that the foreign patents had expired, and therefore the American patents are invalidated, are taking further action. They first of all deny the expiration of the foreign patents, and further deny that the expiration of a foreign patent, in point of fact, does invalidate the American patent, holding this latter point to be an absolutely impregnable position, the essence of equitable law and common sense, and will go to the Supreme Court to defend this position.

"Incandescent" Motor.—A curious anomaly appears to be cropping up in the nomenclature of motors in America. We recently saw a description of a plant where a "6h.p. incandescent motor" was mentioned. No doubt this description applied to a motor to be used on low-tension constant potential incandescent light circuits; but to call a motor "incandescent" is a peculiarity which English engineers would hardly stand. We should advise the American technical press to insist on suppressing this anomaly at once, and start off by calling their motors low-tension and high-tension motors, or L.T. and H.T. for short, or some more suitable and correct technical term.

Birmingham.—A notice has been served on the Town Clerk at Birmingham last Saturday, that it is the intention of Messrs. Chamberlain and Hookham to apply to the Board of Trade for a provisional order. The present intention is to embrace a square comprised within the following streets:—New-street, Colmore-row, Bull-street, and High-street, the current being supplied from Messrs. Chamberlain and Hookham's works in Bartholomew-street. If, as there is reason to believe will be the case, applications are received for the electric light from persons outside this radius, the area will be extended. The system to be used will supply a continuous current of electricity, and at the central station there will always be a large storage force in reserve, so that there will never be any risk of a failure in the light.

How to Improve the Telephone Service.—In New Zealand there are upwards of 2,000 telephones at work, or an average of one telephone to every 100 people in the areas served. At the same rate London would require just ten times the number of instruments at present in use, and the Sandwich Islands can beat even the New Zealand record. Now, here is an idea for the United Telephone Company, says the *Financial News*. In order to see how it is done, let Mr. Morgan, the managing director, go, say, to the Antipodes first and to Honolulu afterwards. Travelling expenses would cost the company less than his weekly journeys to Liverpool and back, which evidently lead to no improvement. While he was gone ample reforms might have a fair trial, and on his return the new ideas he had picked up might be of value.

Motor Printing in New York.—A very significant expression of opinion as to the desirability of the electric motor, says the *Electrical World*, has just been given by the well-known printing firm of Thurber, Wyland and Co., of New York. That firm learning that another large house was debating whether to put in the motor or the steam-engine, went to the trouble of writing to the firm and advising it strongly to try the Sprague motor, which they themselves found to be far better than the steam-engine for their printing office. To use their own language, "It is simpler, more efficient, needs no repairs, as there are all the time on the steam-engine, does not heat up the building, requires no engineer with a certificate, and is more economical. It does not affect the insurance, and the underwriters give permits for it. If you will investigate the experience of others who are using the motors, I think you will not consider putting in a steam-engine." This letter is signed by the chief partner, Mr. F. B. Thurber.

Drury Lane Theatre.—The annual general meeting of the proprietors of Drury Lane Theatre was held last Saturday in the saloon of the theatre. The balance was a good one, many improvements have been made, the exits have been altered, five new doors have been opened, two staircases constructed to the dressing-room, and additional doors added on the stage, and the rent had been paid to a day. But one thing was wanted, said Mr. Percy Lloyd. Electric light had been adopted at many other theatres, and why should not the committee give their attention to the question of using the light at Drury-lane. The great danger they had to guard against was fire, which, during the last few years, had caused so many fatalities. Nothing seems to have come of Mr. Percy Lloyd's suggestion at the moment, but we have little doubt that the proprietors of the "home of pantomime" have seriously thought of the question, and will shortly have to adapt themselves to the extended resources of science. The committee, as re-elected, consists of Sir George Armytage, Captain J. A. Ford, and Messrs. Edward Chitty, Edward Hicks, Jonas Levy, and Roberts Walters.

Electric Level-Crossing Signals. — An electric alarm for protecting the public using level-crossings on railways has been devised by Mr. William T. Folks, of 30, Mark-lane, London, where a large working model is to be seen. At the proper distance from the crossing a spring placed by the side of the rails is pressed by the wheels of the engine passing over it, which makes circuit and starts an electric bell placed at the crossing point; this continues to ring until the train has cleared the crossing, and has reached a point at a given distance beyond it. Here the flange of the engine-wheel presses another spring, and sends another current back to the bell which causes it to cease ringing. This simple contrivance will enable the public to be protected against the dangers of level-crossings, for the bell is set ringing before the train reaches the danger-point, and does not cease until it has well cleared it. The peculiarity of this invention is that the current is not used itself for ringing the bell, but indirectly for turning on the current which is to ring the bell. The invention is said to have received the approval of several railway engineers.

Folkestone.—At a council meeting at Folkestone, on Friday last, Mr. Logan said there was a very general feeling

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in the town in favour of the electric light, and he proposed, "That a provisional agreement be entered into for three years with Messrs. Laing, Wharton, and Down, or some other firm, for lighting that part of the town which was situated within the area bounded by Sandgate-road on the south, Shorncliffe-road on the north, Earls-avenue on the west, and Cheriton-road on the east, subject to such modifications or reasonable extension as may be deemed expedient." He believed that the electric light would be found to be cheaper than gas. Mr. Vaughan wanted a larger scheme, as they required the light as much or more in the east and north of the town as in the west. But it was suggested that this could be regarded as an experiment, and if successful, the light could be extended all over the town. Alderman Sherwood objected to experiments being carried out at the public expense, and Mr. Salter wished to get further information. The resolution was carried, seven being in favour and three against. The names of the committee are: The Mayor, and Councillors Holden, Spurgen, Logan, and Thompson.

Dublin Lighting.—A special meeting of the Dublin Corporation was held yesterday week to consider and take action on the letter of the Board of Trade on the subject of electric lighting. A resolution was proposed as follows: "That the conditions contained in the letter of the Board of Trade of July 10 be accepted, and they be requested to issue a license in accordance with the conditions contained therein, but so far as the completing of the installation, at present contemplated within two and a half years, the Council desires that the clause of the license should be so framed as to leave it open to the Council to make subsequently such further extension of the system within the city as the Council may from time to time consider advantageous." Some observations were made with regard to fixing the limit of time. It was thought that a term was used in the resolution which might cause trouble in the future. The Corporation had agreed to a limit of time being fixed within which the contemplated works should be completed. Although they might be completed so far as the present works were included, if they wanted to extend or do more lighting they would have to go to the Board of Trade for another license. Whatever works or plant they erected in two and a half years they would be obliged to discontinue after that time, and a limit of time might involve them in difficulties. They had undertaken to do the electric lighting within two and a half years, but they did not know what would be necessary to complete it, and it was thought better that the Council should strike out the word "complete." The resolution was carried unanimously.

The Coming Boom.—*The Financial News*, in its issue of July 26, has a leading article upon what it terms the "Coming Electric Light Boom," in which it points out that in 1881, when it first appeared upon the scene, the electric light, like all startling novelties, ran riot in its own fascination. It sowed its wild oats with a vengeance, and has since had to do penance in sackcloth and ashes. The reaction came and everybody who could gave it a kick. Our contemporary says, "To have lived through such an ordeal is of itself ample proof of its vitality." It goes on to point out that another turn of the wheel has come round, and this time a favourable one. Our financial contemporary, considering its special experience, says: "The science of electric lighting has been greatly developed; electric engineers have accumulated practical experience, and they now have some notion of the limits of their powers; crude and visionary ideas have been weeded out, and schemes have been framed which are both scientifically and financially practicable; exact and reliable data have been obtained as to the actual cost of electric lighting under various circumstances, and on the highest authority it can be affirmed that electric lighting companies may now, with good management, do a very profitable business in any of our large towns. *Prima facie*, there is no reason why they should not. In the United States many of them are paying large dividends, and their shares are among the most solid and popular of investments."

The Paris Electrical Exhibition.—In reference to the statements made by the Lord Mayor, in his speech at the Mansion House banquet on Saturday evening last, we cannot but express surprise at the meagre manner in which English electrical industries threaten to be represented. English exhibits as a whole will be a full representation of the manufactures of the country, but those representing the industries in which we are specially interested will, as we have said, be very meagre and incomplete. Many of our largest firms are holding aloof, although we understand that appeals, both personal and otherwise, have been made to them by various representatives of the Paris Exhibition Executive Committee, and by the Society of Telegraph Engineers and Electricians. It is presumed that the feeling generally is that exhibitions do not pay. We doubt this very much: they may not pay directly, that is, few or no orders may be traced to the exhibitions themselves, and we may be told that French tariffs practically exclude many articles of English manufacture, but in cases of this kind sometimes the benefits accrue long after the effort has been made; and an exhibition in Paris does not mean an exhibition only to Frenchmen, but to the world. Those who have articles which are worthy of introduction to South Americans, Chinese, and Japanese, may all find it a convenient centre for the display of their wares at the forthcoming Paris Exhibition. We trust that even yet it is not too late to find some of our leading firms avail themselves of the saving clause by which the Lord Mayor held that, although the present space was fully appropriated, yet some extra room might be found for exhibits of a specially interesting character that might come in at the eleventh hour.

Electrolysis by Alternate Currents.—A very interesting paper has been communicated to the Académie des Sciences by MM. G. Maneuvrier and J. Chappuis with reference to the evolution of gas by means of alternate currents. When alternate currents are sent through an ordinary voltameter, with plates or large platinum wire electrodes immersed in water acidulated with pure sulphuric acid, no evolution of gas occurs, and it appears as if the acidulated water were not decomposed at all by alternate currents. For instance, with current of 4 or 5 amperes at 250 to 300 volts, which would easily light either arc or incandescent lamps, no traces of evolution of gas at the electrodes can be observed, providing the dimensions of the electrodes exceed 1 millimetre ($\frac{1}{25}$in.) diameter, and 4 or 5 centimetres (1½in. or 2in.) in length. The opinion has thus been promulgated that alternate currents do not produce electrolytic action. But the authors observe that this opinion is erroneous, and the absence of electrolytic action is only apparent. If very fine wires are substituted for large electrodes in the voltameter, the same alternate currents immediately cause an abundant discharge of gas. The authors consider that a double chemical action goes on where large electrodes are used, and indicate that, with proper

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precautions, the reactions, direct and indirect, are strictly proportionate to the quantity of electricity traversing the voltameter. The total effect may be realised by utilising the double chemical effect by forming suboxides, and in this manner it would be possible to construct an electric meter for use on alternate current systems. They remark, however, that the evolution of explosive gases in this way renders the experiments exposed to continual small spontaneous explosions if certain precautions, which they intend to indicate in a further communication, are not taken.

Fuel Testing.—The anomalous position of fuel consumers in London is very apparent when we reflect that many works are driven to consume Welsh coal at eighteen shillings a ton to insure smokeless chimneys, when other and much cheaper coals having equal heating power are practically prohibited on account of their smoke-producing qualities. Mr. Lavington Fletcher showed at the Wigan trials how Lancashire boilers could be fired by hand without smoking; but the difficulty is in getting firemen sufficiently adaptable to manage the fire properly in accordance with the true principles of combustion. Mr. D. K. Clark, of 8, Buckingham-street, who acted as testing engineer to the Smoke Abatement Institution, holds that the practical solution lies in the direction of automatic action, the principle of the gazogene, for instance, in various forms, in which the solid fuel is converted into combustible gases, or that of the mechanical stoker. Experience has proved that by such means not only may smoke be prevented, but the fuel can be thoroughly and economically consumed with high evaporative efficiency. Mr. Clarke has satisfied himself from the results of long and carefully-conducted observations, that with ordinary north country slack, the cost of production of steam can be reduced by from 40 per cent. to 50 per cent. of the cost with smokeless Welsh coal; when pound for pound, the north country coal was nearly as efficient as the Welsh coal. Boiler heating by means of fuel gas is in constant use in several large installations in America, and the cost for firemen and engineers will be merely nominal in such cases, and the greatest heating effect produced. The plant required, however, is larger, and in England more attention has been paid to that of automatic stoking, and means for using a cheaper fuel such as slack. Much greater attention might with considerable financial advantage be paid to these points, especially by south country consumers, where the cost of coal is high. There are boilers at cutlery works in Sheffield which are instances of furnaces fed on a principle of this kind which enable common slack at five shillings a ton to be used, and the cost of boiler power would appear incredibly small to enforced users of the high-priced coals.

Conversazione at the Temple.—A conversazione was held yesterday week in the hall and library and adjoining apartments of the Inner Temple, and invitations were issued by the treasurer, Sir Patrick Colquhoun, Q.C., and the benchers had issued invitations for what was called a "Scientific At Home." For this occasion the beautiful hall of the Inner Templars was illuminated from outside by 22 arc lamps of 3,000 c.p., driven by a Crompton machine. A large number of electrical instruments were exhibited, and an artificial cable equal to 570 miles of submarine wire was erected. Along this messages were transmitted into the next room—representing New York, or the other side of the Atlantic generally; and the guests of the benchers had the serene felicity of watching the messages come out on slips of paper, whence they were read off by obliging manipulators. Accumulator safety lamps, batteries for driving railway carriages, old and new syphon recorders, a writing telegraph, war balloons suspended from the lofty ceiling, which at a given moment flashed forth their electrical signal to the army supposed to be encamped below, were all to be seen by the learned members of the Bar. A Wimshurst machine, labelled "dangerous,' of course was surrounded by a crowd of admiring visitants attracted by the crack of its 18in. spark. Telegraph and telephones were placed to represent London, Leeds, Aberdeen, Edinburgh, and so on, between which dispatches were sent to represent the method of communicating. The benchers had the further delectation of listening to the sweet strains of "The Flowers that bloom in the Spring" through a telephone laid on to the Savoy Theatre, and could realise that the real sounds were being transmitted when the muffled sound of applause came along the wire. A buoy lighted by electricity, "capable of remaining alight for two to four months," is well worthy the attention of naval as well as legal minds. The conversazione was eminently successful, and must be taken as a pointer to indicate how far pure modern science is invading all domains of civil and professional life. The halls and chambers in the Temple will, before long, be permanently lighted by electric light, a foretaste of which was given at the conversazione.

An Electrified River.—At Ansonia, Connecticut, they have an electric railway running, in which considerable difficulty has been always experienced with escaping currents. It affects the telephone system, causing a buzzing sound, and occasionally causes the annunciators to fall at the exchange. "Last week," says the New York *Sun*, "Mr. C. D. Warner, a local electrician, determined to test the power of the escaping current. A wire was grounded near the electric plant in Derby, no connection being made with the track, and was then run into his office in Ansonia, some three miles away. Here it was connected with the gas-pipe at his desk. The wire was cut, and a Maxim incandescent lamp was attached to the ends. The lamp was of 55 volts, and 16 c.p. The carbon at once began to glow, and as a car passed along Main-street in front of his office the lamp gave forth a clear light as strong as if on a regular light wire. As the car rolled further and further away the light grew dim, but when the grade at the foot of the Derby Hill was reached, and the motor took more of the current from the wire, the lamp again shone forth as brightly as ever. An Edison lamp was also attached, and though this required 120 volts to cause a regulation light, it showed up clearly, and gave forth light enough to read by. It remained for the ever-present small boy to discover a benefit in the escaping electricity. Not far from the street where the tracks are laid runs the Naugatuck River. In this the boys are wont to bathe. On Saturday, when the youngsters meet in swimming, they were astonished at the peculiar sensation they experienced. It was not at all disagreeable. On the contrary, it was pleasurable, though at times some of the boys would give a jump and a yell as though they had stepped on a piece of glass and cut their feet. The feeling was so pleasant that some of them remained in the water for hours, and only came out when hunger forced them to go home for supper. It is learned by experiment that the sensations were caused by the electricity, and it is proposed by the shrewd Yankees of this money-making town to lease the banks of the river and establish bathing-houses, that people may take a pleasant, invigorating electric bath at a small cost.

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Testimonials.—We are indebted to the *Leamington News* for the following testimonials from persons of distinction in *re* the electric light at Birmingham:

Mr. GLADSTONE: Am so much charmed with the sweetness of your light that I shall have an installation at Hawarden, assured that it will pave the way for a *rapprochement* between your distinguished but errant brother and his natural leader, while enabling me to fell my stately oaks at night and elaborate a plan of Home Rule which any one can see through.

Lord SALISBURY: Could only have emanated from the brain of a Chamberlain—or a Salisbury. Congratulations on its splendid success. May its shadow never grow less. Am simply deterred from giving you a commission by the fear that if it were introduced I should not be able to hold any more dark *seances* in my Cabinet. Arthur, come up higher.

Lord RANDOLPH CHURCHILL: It's a light that never plays fast and loose. Therefore,

I love it—I love it, and who shall dare
To chide me for loving a light so rare!

The MAYOR: It's the best light for keeping order by.

Mr. PARNELL: Your light is the only thing I love. Forgery flies before it. My blessing follow you all the days of your life—and never overtake you as long as you live!

WILLIAM SHAKESPEARE: "Put out the lights."

Dr. THURSFIELD: "The light that never was on sea or land."

Mr. BRIGHT: "Shine on."

The TOWN CLERK: The best of lights: for it makes the dullest see my jokes.

The CHIEF CONSTABLE: Never knew such a light to run 'em in by.

The POSTMAN: It *light*-ens our labours, parcels notwithstanding.

The TOWN CRIER: 'Tis the only friend I have. It lets me cry by night as well as day.

The MASHER: 'Tis the light to show up your form.

The LADIES: 'Tis as

The light that lies
In woman's eyes.

The CHRONICLE: 'Twas good; 'tis bad.

"'Tis true, 'tis pity; pity 'tis, 'tis true."

The MEMBERS of the CLUB: Everybody's light. Overpowered by its effulgence, we have turned Joseph's face to the sunshine—we meant to say, to the electric light; and peace and harmony will reign for ever and a day.

Mr. CR-WTH-R D-VIES: Never saw such an illuminant. I can see a brief with it My dear Arthur: Let your motto be, "Brief as lightning." Exchange Nelson's telescope for Joseph's eye-glass, and I am with you light for light. Countermand the brandy and pistols.

The COOK: 'Tis "Robert's" unfailing guide to the kitchen.

Glasgow Technical College.—We have received, by courtesy of Prof. Andrew Jamieson, M.I.C.E., F.R.S.Edin., a copy of the syllabus of the day and evening classes at the Glasgow and West of England Technical College for the session 1888-89. The curriculum is a most complete one, and the utmost pains have most evidently been taken to obtain the greatest advantage in point of studying both practical as well as theoretical work for the students who join the college. Since every student is required to show proficiency in the use of ordinary workshop tools before obtaining the college diploma, a special class is held daily for students who have not previously gained experience in working in wood and metals, or in electrical instrument making. In addition to this a class is held for regular workshop students who desire to make up for any deficiency in their apprenticeship, and to get a turn at pattern-making, a department too often missed in confining the attention to drawing, fitting, and turning. A junior course of electrical engineering consists chiefly of laboratory work, with lectures and demonstrations, comprising the following: The resistance of conductors by the Wheatstone bridge, and by other methods, combined resistance of shunts and galvanometers, and of wires or electric lamps joined in "multiple arc"; the resistance of lightning conductors and of earth circuits; the percentage variation of resistance of different materials used in electrical circuits for rise or fall of temperature; the specific resistance of different materials; the internal resistance of different battery cells; the difference of potential and E.M.F. of different kinds of battery cells; the measurement of currents derived from batteries, construction and management of batteries for different purposes; the graduating of galvanometers and meters by the electrolysis of metals and by other methods; the measurement of the specific inductive capacities of different dielectrics, the construction of condensers, influence of capacity on the retardation of submarine cable and subterranean line signals, &c.; insulation resistance of different materials by aid of Sir William Thomson's galvanometer and electrometer; determination of the magnetic elements. The senior course is intended for those who intend to become electrical engineers, who will be taught how to carry out practical tests with the college engine, dynamos, and storage cells, &c., with work in the drawing office, the laboratory, such as calculating the dimensions for and designing the form of dynamos, motors, and transformers, &c.; writing out specifications for the same and for electric lighting and transmission of power installations, as well as plotting out characteristic curves. Instruction will be given in the following: Measurements of magnetic circuits and plotting out of magnetic curves, testing of dynamos working at different speeds, and plotting the characteristic curves; charging and discharging storage cells, with rules to be observed in order to prolong their life and efficiency; the working of the college condensing and non-condensing engine, taking of indicator diagrams, and making brake and other tests; ascertaining the efficiency of steam-engine and dynamo, separately and as a whole; photometric tests of arc and incandescent lamps; testing transformers and finding their efficiency by the calorimeter and by other methods; electro-plating, electrotyping, and the deposition of metals generally by electricity; electric welding on a small scale; drawing office work; visiting electrical installations, and writing out descriptions of the same with sketches. The college engine is a splendid experimental engine, which has been purchased for the college, costing over £300. A special feature of the teaching in connection with indicator diagrams is the selection of some of the best students in each section to take indicator diagrams and brake horse-power tests of the college engine, while the others watch the operations and take notes. The whole class then have to work out the horse-powers and find the efficiency of the engine. Courses on magnetism, on static electricity, and for electrical testing and research are also arranged. Courses of lectures on electrical engineering by Prof. Jamieson, assisted by Mr. James Livingston, A.S.T.E., are arranged with special regard to the departments of telegraphy, telephony, electric lighting, and electric transmission of power. Other courses on mechanical engineering, and on steam and steam-engines, both theoretical and practical, complete the syllabus of what must be termed a most serviceable and comprehensive course.

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NOTES ON DYNAMO CONSTRUCTION.

BY SYDNEY F. WALKER.

(Continued from page 52.)

The drum armature has many considerable advantages. Our American friends early discovered this fact. As they put it, the dynamo that was constructed as though it was wholly of iron—field-magnets, armature and pole-pieces being in one mass, and then had a cylindrical piece cut out where the poles are situated, and wire wound in the cut—formed a remarkably efficient machine. Years ago, too, at the Trinity House trials between the Gramme and Siemen's machines, the latter had the decided advantage, and we now know that it was on account of the very much lower resistance of the magnetic circuit, owing to the greater mass of iron in the core of the armature, its length, and the form of the field-magnets. By properly constructing the armature, however, the ring and disc pattern can be made to contain very nearly as much iron as the drum pattern; not quite, of course, on account of the necessity for providing for the driving arrangements, and the internal copper wires. The Siemens' has also a decided advantage in the matter of the electrical resistance of the bobbin. In the ring pattern only half the wire is doing work, while in the drum pattern all the wire is, except that crossing the ends, which, in a bobbin whose length greatly exceeds its diameter, is not much. So that there is a smaller charge on the total E.M.F. generated for the resistance of the armature, adding, of course, to the efficiency of the machine. Against this there are the serious practical difficulties, that the armature is more difficult to wind, especially if there are to be many sections; that the coils overlap one another at the ends, so that two wires at highly differing potentials may be in close contact, and a spark caused by a sudden change in the outer circuit may break down the insulation and burn the coils. The Siemens' winding has also the disadvantage that it necessitates double the number of layers. You cannot wind a drum armature so that the coils are in series all round the bobbin without going twice round. Taking, say, for simplicity, eight coils and eight sections of the commutator with Gramme winding, you would divide your periphery into eight sections and wind a coil in each. With the Siemens', however, you divide your periphery as before; but when you have wound four coils, or half the total number, whatever that may be, you have filled up the surface of the bobbin, and to get in your other four you have to go round again; you cannot get over the difficulty by winding every other coil from opposite sides, as you will then have, side by side, wires in which the full difference of potential of the machine exists. In any case, as before explained, you have this with the wires crossing the ends. The necessity of having two layers of wire also leads to another serious drawback—viz., the core is thrown further back from the pole-pieces. The electrical resistance is not affected as the same number of turns being required, your wires may be of double the sectional area, but this again tends to increase the space occupied by the copper wire, and to throw the core still further back. The increase of magnetic resistance, due to increased space occupied by air and copper wire, is partly neutralised by the decreased magnetic resistance of the core itself, but not all, and a consideration of the above will show that the claims of Gramme and Siemen to superiority under modern conditions are by no means easy to adjudicate on. In the early days, when both types had a great many layers of wire, the Siemens' had undoubtedly the advantage. At the present time the question is one which can only be answered by actual figures in each individual case. Another point that deserves consideration is, that in order to re-wind a coil of a drum-armature when burnt, it is necessary, if it happens to be an underneath coil, to strip the whole armature. It is as well to point out here, however, that shunt-wound machines can only burn their armatures through defects in the armature itself. No lowering the resistance of the external circuit will do it, as the effect of the latter is to lower the E.M.F., and when the external resistance = 0, the E.M.F. = 0 also. The drum armature has also the advantage, that all the wire is exposed to the air, though, again, the wires crossing the ends have not so much ventilation as some modern type of Gramme armatures. Ring armatures have been adopted more generally in England no doubt on account of the patent rights having been freed at an earlier date, but they have undeniable advantages, among which simplicity of winding is by no means to be despised, and the fact that any coil can be replaced without stripping the armature. Disc armatures have only been adopted in a few special cases, such as the Brush, the Schuckert, the Victoria, and the Gülcher. There are several serious drawbacks to this form of armature. One is the difficulty of laminating the core in the direction of the lines of force, and at the same time providing for efficient driving. Where, as in the Brush machine, the lines of force all pass through the ring parallel with the axis of rotation; the desired lamination may be effected by constructing the core of ribbon of a width equal to that of the core itself, and there is not much difficulty in holding this mechanically so as to drive properly. But where, as in the "Victoria," the "Gülcher," and others, the pole-pieces are in the form of a shoe, enclosing the armature on three sides—that is, its periphery and part of its two vertical faces—then, as the lines of force must enter from the periphery as well as from the sides, only lamination in every direction, such as a wire core gives will meet the case. Here comes in the difficulty of driving; as, in order to preserve the form of a disc of wire, it will be necessary for it to be held in forks, or some equivalent appliance for a considerable portion of its radial depth, and these forks will not only take up some of the space that would be occupied by the copper wire, but will also necessitate the core being further from the pole-pieces on its vertical faces. The writer believes that no core made wholly of wire has yet been used for disc armatures. Mr. Brush has, as usual, got over the difficulty in a novel and ingenious manner, though his recent improvements show the earlier machines to have been exceedingly wasteful in this matter. In fact, it is no uncommon thing to find the iron core of an old type "Brush" armature hot, while the wires on it remains cool. Dr. Hopkinson has shown that the loss due to Foucault currents in the "Brush" armature was not so great as it might have been, if, instead of the disc being an iron casting, it had been made of wrought iron; owing to the fact that cast iron has a considerably higher electrical resistance than wrought iron. It would be interesting to know whether the gain from the increased electrical resistance is equal to the loss due to the increased magnetic resistance, or *vice versâ*. Other makers of disc armatures appear to have adopted a sort of compound core, built up with a small cast disc for a foundation, and then ribbon, which latter has been slotted radially, in order to provide what may be termed breathing spaces for the air current to pass through, and in order to lessen the Foucault currents. Another plan, adopted by the Gülcher Co. in some of their machines, is to have a central disc of wood, with projecting wood teeth on its periphery. On each vertical face of the wood disc are screwed thin iron discs, and the copper wire is wound over all in the space formed between the wood teeth. The driving arrangement on this armature smacks very much of the old wood hub. It consists of two flanged brass hubs, entering the armature from opposite sides and held together by bolts and nuts, the inner diameter of the armature being formed V shaped, to take the grip of the hubs, and protected by leather. The arrangement seems a remarkably good one mechanically, but it evidently has a high magnetic resistance. The disc pattern of armature gives one very great advantage over other forms, at any rate as generally constructed. It allows a free circulation of air over a large portion of its surface, so that for given work, other things being the same, a smaller gauge of wire should be permissible. Further, there is very little fear of the periphery of the disc armature rubbing on the pole-pieces; but there is great fear of its vertical faces doing so, should there be any end play. For this reason, the spindle of disc dynamos have to be provided with some special arrangement, such as grooves running over corrugations in the bearings, or other special fittings, to prevent motion of translation and consequent rubbing. The Pacinotti form of armature, in which the core is formed of a series of toothed iron wheels insulated from each other and held together on the spindle, the

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wire being wound in the grooves formed by the teeth, has, in the writer's opinion, very little to recommend it from a practical point of view. In the first place, the machinery required to work these plates is very much heavier and more expensive than that used in forming wire cores. It is also far more difficult to ensure that you have not left some little point or burr sticking up that will in time work through the insulation, and it is far more difficult and more expensive to wind than either the Gramme, Siemens, or disc patterns. It has already been mentioned that some portion, at least, of the advantage due to decreased magnetic resistance is sacrificed, owing to the heating of the pole-pieces; and it is the writer's opinion that there is absolutely no gain in the output of a machine using a Pacinotti armature over one using either a drum or ordinary ring core. To put the case in another form: If a dynamo machine be constructed with field-magnets of a certain size, and two or more armatures be constructed for it, one of which shall be a Pacinotti and the other either a Siemens or an ordinary Gramme, using the same weight and length of copper wire for both, it will be found that the ordinary Gramme would be equal, if not superior, to the Pacinotti. As Prof. Silvanus Thompson and Mr. Esson have both expressed themselves to the contrary, and the latter has maintained the courage of his opinions by constructing the dynamos of his firm on the Pacinotti plan, it may be well if the writer's reasons for the above opinion be stated. Both Professor S. Thompson and Mr. Esson's opinions have —the writer believes—been derived from experiments that were misleading. In each experiment only a portion of the surface of an armature was wound, vacant spaces being left. In one case these spaces were filled in with iron, and in the other case two rings were made, one with teeth and the other without. In each case the surface of the core on the inner side of the outer copper wire was at the same distance from the pole-piece, so that the effect of using teeth in one case and fixing iron in the vacant spaces in the other was to directly reduce the average magnetic resistance. It is evident, however, that whatever the portion of the periphery occupied by the teeth may have been, the magnetic resistance could have been reduced equally as well by bringing the whole surface of the core nearer the pole-pieces, and reducing the layers of wire, but maintaining the same number of turns. Take, for instance, the case of an armature, half of whose surface is occupied by these teeth, and having four layers of wire. If the teeth be cut away, and the diameter of the core increased by half the depth of the teeth, the magnetic resistance would be the same or less, and the winding space greater, as the two layers of wire would be wound on a larger circumference, and there would be no space taken up in insulating the teeth themselves, while the winding would be easier. In addition to this, the channels in which the wires lie do not allow of ventilation, and, in fact, tend to lower the possible density of the current as they become very hot. The armature has, however, one advantage: the projecting teeth protect the wire from rubbing on the poles. The new armature of Mr. Chas. Lever, in which a portion of the Pacinotti projections are carried into grooves in the pole-piece, form a striking instance of ingenuity in reducing the resistance of the magnetic circuit; but in the writer's opinion it is doubtful whether the gain will not be a minus quantity. The construction appears to him to be open to all the faults of the Pacinotti, and to be more expensive.

(To be continued.)

ELECTRICAL ENGINEERS.

I.—MESSRS. R. E. CROMPTON AND CO.

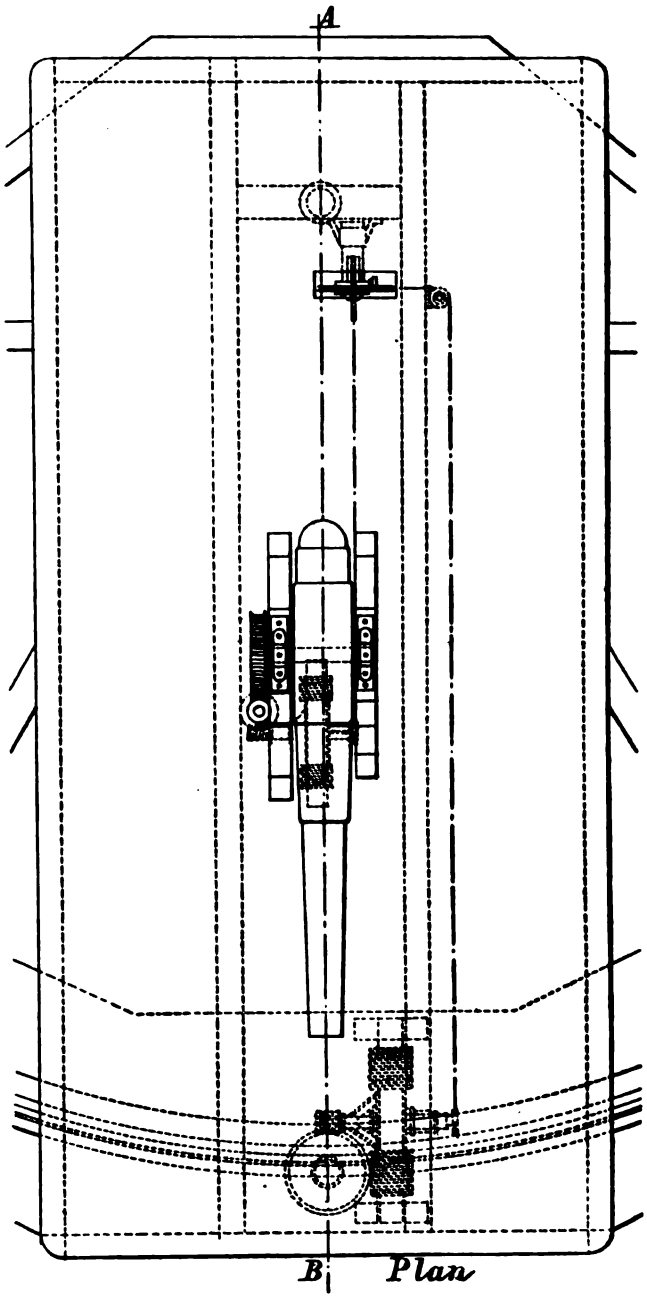
(Continued from page 58.)

Electrical Gun-Training Gear and Electric Crane.

At the works of Messrs. R. E. Crompton and Co., Chelmsford, as mentioned in our description of their works last week, some special pieces of electrical apparatus were shown, and experiments were made to show the capabilities of the electro-motor applied to certain engineering problems. One of these was a gun-training gear, mounted upon a carriage, a model of the apparatus applied to a 38-ton gun at Woolwich, and the second an electrical crane to be used for unloading timber, &c., for the roof of a warehouse near a wharf.

Gun-Training Gear.

The first illustration shows the apparatus on plan. Two electro-motors are fixed beneath the platform, one to effect the action of rotating the platform through a portion of a circle, the second to effect the raising or depressing of the gun itself. The gun is mounted upon a platform having a certain radial revolution, geared to a quarter circle of rail, cogged on its side, to a small tooth-wheel, which itself is rotated by a worm gearing attached directly to the motor.



The gun itself has a tooth-wheel connected to its axle, which is likewise geared to a worm-gearing which can be rotated by means of the second electro-motor.

The regulation of these motors is effected, not in the usual manner with resistances or other apparatus, but by the shifting of the brushes, the motor being specially wound, so that it can be started, stopped, reversed, or run at any desired speed, merely by adjusting the position of the brushes upon the commutator. This being so, a simple movement to the right or left of a handle connected to a wheel, over which passes a chain to pull the brushes backward or forward, will be all that is necessary to regulate the motor. A simple and ingenious contrivance is used to effect the necessary movements of the brushes of both motors with one single handle, so that the rotation of the carriage and the elevation or depression of

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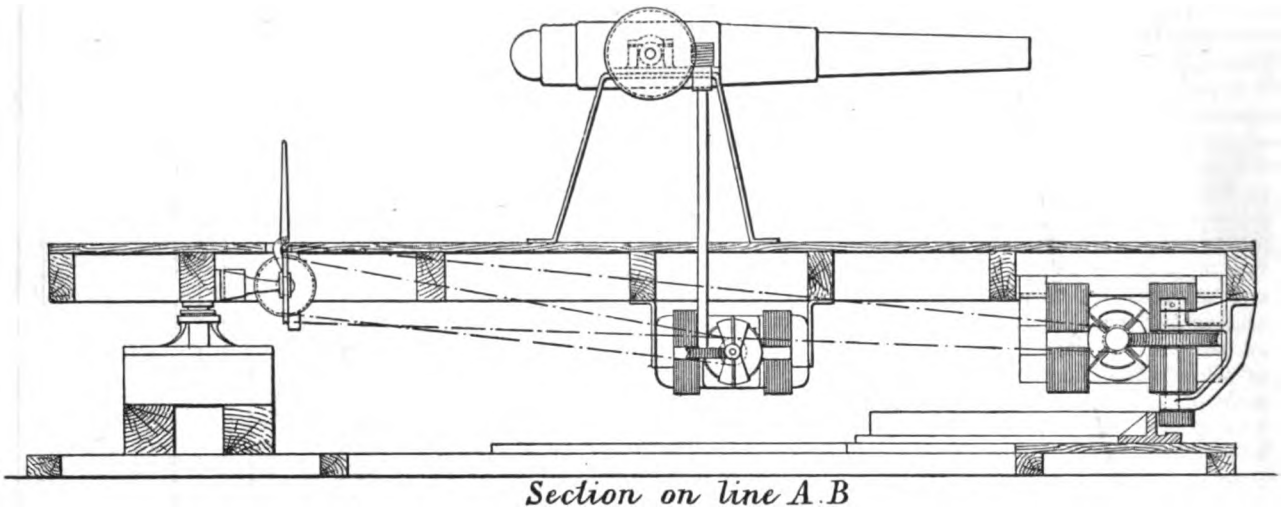
the gun are accomplished with the greatest ease, either together or separately, and moving in either direction as desired.

This is accomplished by the action of two wheels mounted together at right angles to each other, so that their various movements can go on at the same time, one wheel moving (so to speak) to the east and west, and the other north and south. The movement of these two wheels is effected by a lever with a peculiar crook in its end, seen in the illustration. On moving this lever forward or backward one set of brushes is moved, and the revolution of the platform is accomplished. On moving the lever in the direction of right and left the other set of brushes is moved, and the gun is depressed or raised as desired. These two motions can go on simultaneously in either direction, or independently of each other. The gun can be trained through a full horizontal angle of 80deg. in about 25 seconds, and elevated and depressed through the full range in 12 seconds.



Section on line A B

The second illustration shows the apparatus in side elevation and section.

Electrical Crane.

An application of the same type of motor to the construction of a crane was also shown. The motor is geared to a main-shaft on the platform of the crane. This is kept rotating at a constant speed while the crane is in action, and friction gear is adapted by means of bevel wheels, so that the three motions of travelling, steering, and hoisting can be separately or simultaneously operated from the one motor. The crane will hoist one ton 80 feet in one minnte. The speed of the motor is constant, and the E.M.F. is also kept constant; the current varies with the power required from about 10 to 45 amperes with a pressure of 95 volts.

THE RELATIVE MERITS OF IRON AND LEAD COVERING FOR CABLES.

BY DAVID BROOKS.

Among the advantages of iron over lead, beside cheapness and greater strength, wrought iron is free from pores. In coiling and uncoiling lead you are liable to open pores. As lead tubing is coiled, the outer surface of the tube forming the circle is elongated and the inner surface compressed, and this condition is produced by the comparatively rigid nature of the cable or conductors inside. If the insulation consists of paraffin, which is all broken up by the coiling, the moisture goes directly to the conductors. If it goes to the mixture of resin and resin oil it stops there, provided it does not reach the textile covering. In that case it finally penetrates the covering and reduces the insulation. Wire after wire will fail. Wrought-iron pipe is rigid and has no pores, that being proved under a pressure of from one thousand to two thousand pounds to the square inch. The socket-joints are rendered moisture-proof by the use of a cement of white lead and linseed oil; but supposing the socket-joints are not perfectly moisture-proof, the insulating material is poured directly into the socket at a temperature of 400 degrees Fahr. and fills all apertures. On cooling, it will remain and prevent all ingress of moisture. When lead is drawn over a cable the textile covering comes directly in contact with the lead, and the pores opened in the lead admit moisture to the textile covering. Thereby insulation fails. In iron pipe the position of the cable is shown by two circles, the outer circle representing the pipe, the inner circle that of the cable. The space between the two circles is filled with the insulating mixture, which is heavier than water and does not crack or check, being semi-fluid at a temperature below freezing. It will be seen that the chance of moisture reaching the cable is exceedingly remote. Lead-encased cables are very little used in this country except for telephonic purposes, and then for short distances, seldom over a mile. Telephones can be worked for that distance with very low insulation. To remedy the difficulty—porosity of the lead—they are sometimes laid in a trough and covered with pitch. Felten and Guilleaume cover the cable with a braid saturated with bitumen. Berthoud-Borel draw on one covering of lead and cover that with an insulating material, and over that draw a second lead covering.

As to comparative cost, a lead cable 1in. inside diameter, of the weight usually used in this country, costs 12 cents per foot or upwards. An iron pipe, lap-welded, 2½in. diameter, suitable for the purpose, can be had at 12 cents per foot. The capacity of the iron pipe is over six times that of the lead, and it can be made to contain six times as many conductors with the same amount of covering or insulation, or we can give the conductors six times the insulation and less than one-sixth the electrostatic capacity. It is a very easy matter to make an electric light conductor show an insulation of from five thousand to twenty thousand megohms per mile and at trifling expense as compared with ordinary modes of insulation.

The cable that I laid a year ago of this new system shows higher insulation at this time than when first laid. I can say at even temperature it is more than twice as high. It does not cost over one-quarter that of the cheapest of other systems. The insulation is protected by wrought iron. The outer surface of the pipe is protected from oxidation by a coating of pitch or asphalte.

The method of laying it is so simple that any person can do it without previous experience, it being only necessary to strictly follow the printed directions.—*Electrical World.*

A TABLE OF INCANDESCENT LAMP LEADS.

The accompanying table is based on Matthiessen's determination that the resistance between opposite faces of a centimetre cube of pure annealed copper at 0 deg. C. is 1,598 legal microhms; it is calculated for 98 per cent. copper at 75 deg. F., from the formula:

$$d^2 = \frac{20\,D\,C}{P}$$

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TABLE OF INCANDESCENT LAMP LEADS.

SHOWING SIZES OF WIRE REQUIRED TO CARRY FROM 1 TO 1,000 AMPERES FROM 10 TO 10,000 FEET, AT 1 VOLT FALL OF POTENTIAL.

By G. B. Prescott, Jr.

Copyrighted 1888, by Holmes, Booth & Haydens.

Total Current. Amperes.	Distance of Lamps in Feet. 10		20		30		50		100		200		300	
	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.
1	200	27	400	24	600	22	1,000	20	2,000	17	4,000	14	6,000	12
2	400	24	800	21	1,200	19	2,000	17	4,000	14	8,000	11	12,000	9
3	600	22	1,200	19	1,800	17	3,000	15	6,000	12	12,000	9	18,000	7
5	1,000	20	2,000	17	3,000	15	5,000	...	10,000	10	20,000	7	30,000	5
10	2,000	17	4,000	14	6,000	12	10,000	10	20,000	7	40,000	4	60,000	2
20	4,000	14	8,000	11	12,000	9	20,000	7	40,000	4	80,000	1	120,000	0+9
30	6,000	12	12,000	9	18,000	7	30,000	5	60,000	2	120,000	0+9	180,000	000+9
50	10,000	10	20,000	7	30,000	5	50,000	3	100,000	0	200,000	000+5	300,000	0000+1
100	20,000	7	40,000	4	60,000	2	100,000	0	200,000	000+5	400,000	$\overline{0000}$	600,000	$\overline{0000}$+000
200	40,000	4	80,000	1	120,000	0+9	200,000	000+5	400,000	$\overline{0000}$	800,000	$\overline{0000}$+000	1,200,000	$\overline{0000}$+00
300	60,000	2	120,000	0+9	180,000	000+9	300,000	0000+1	600,000	$\overline{0000}$+000	1,200,000	$\overline{0000}$+00	1,800,000	$\overline{0000}$+0
500	100,000	0	200,000	000+5	300,000	000+1	500,000	$\overline{0000}$+1	1,000,000	$\overline{0000}$+000	2,000,000	$\overline{0000}$+0	3,000,000	.....
1,000	200,000	000+5	400,000	2+0000	600,000	$\overline{0000}$+000	1,000,000	$\overline{0000}$+000	2,000,000	$\overline{0000}$+0	4,000,000	.....	6,000,000	.....

Total Current Amperes.	Distance of Lamps in Feet. 500		1,000		2,000		3,000		5,000		10,000	
	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.	d^2 Circ. Mils.	No. American Gauge.
1	10,000	10	20,000	7	40,000	4	60,000	2	100,000	0	200,000	000+5
2	20,000	7	40,000	4	80,000	1	120,000	0+9	200,000	000+5	400,000	$\overline{0000}$
3	30,000	5	60,000	2	120,000	0+9	180,000	000+9	300,000	0000+1	600,000	$\overline{0000}$+000
5	50,000	3	100,000	0	200,000	000+5	300,000	0000+1	500,000	$\overline{0000}$+1	1,000,000	$\overline{0000}$+000
10	100,000	0	200,000	000+5	400,000	$\overline{0000}$	600,000	$\overline{0000}$+000	1,000,000	$\overline{0000}$+000	2,000,000	$\overline{0000}$+0
20	200,000	000+5	400,000	$\overline{0000}$	800,000	$\overline{0000}$+000	1,200,000	$\overline{0000}$+00	2,000,000	$\overline{0000}$+0	4,000,000	.....
30	300,000	0000+1	600,000	$\overline{0000}$+000	1,200,000	$\overline{0000}$+00	1,800,000	$\overline{0000}$+0	3,000,000	.....	6,000,000	.....
50	500,000	$\overline{0000}$+1	1,000,000	$\overline{0000}$+000	2,000,000	$\overline{0000}$+0	3,000,000	.....	5,000,000	.....	10,000,000	.....
100	1,000,000	$\overline{0000}$+000	2,000,000	$\overline{0000}$+0	4,000,000	.....	6,000,000	.....	10,000,000	.....	20,000,000	.....
200	2,000,000	$\overline{0000}$+0	4,000,000	.....	8,000,000	.....	12,000,000	.....	20,000,000	.....	40,000,000	.....
300	3,000,000	.....	6,000,000	.....	12,000,000	.....	18,000,000	.....	30,000,000	.....	60,000,000	.....
500	5,000,000	.....	10,000,000	.....	20,000,000	.....	30,000,000	.....	50,000,000	.....	100,000,000	.....
1,000	10,000,000	.....	20,000,000	.....	40,000,000	.....	60,000,000	.....	100,000,000	.....	200,000,000	.....

Where d = diameter of wire in mils.
„ D = distance of lamps in feet.
„ C = total current in legal amperes.
„ P = allowable fall of potential in legal volts.

To Use The Table.

Find the required current in the first column marked "amperes," and follow the horizontal line to its intersection with the column giving the required distance of the lamps, and divide the number at this intersection, under the head of "circular mils.," by the allowable loss of potential expressed in volts. The quotient will be the d^2 of the required wire, and the corresponding number of the wire, in any gauge, may be found by reference to the ordinary wire gauge tables

For all round numbers from 1 to 1,000 amperes, and 10 to 10,000 feet, at 1 per cent drop, the size of the wire, in American gauge, is given directly by the table. Where greater accuracy is required, the values of d^2 for intermediate currents and distances are separately determined, as above, and then added together, their sum being the d^2 of the required wire.

Examples.

(1). It is required to find the size of wire which will convey current to 200 100 volt ½ ampere lamps, located at a distance of 500 feet from the source of current, at 5 per cent. loss of potential.

Method.

Two hundred lamps of ½ ampere each will require 100 amperes, and 5 per cent. of 100 volts makes the allowable loss of potential five volts. At the intersection of the 100 ampere line, and 500 feet column, "circ. mils." = 1,000,000.

$$\therefore d^2 = \frac{1{,}000{,}000}{5} = 200{,}000 \text{ cir. mils.} = \text{No. } 000 + 5 \text{ B \& S}$$

(2.) It is required to find the size of wire which will convey current to 50 lamps of 50 volts and 1 ampere each, for 150ft., at 2 per cent. drop.

Method.

Fifty lamps of 1 ampere each will require 50 amperes, and 2 per cent. of fifty volts makes the allowable drop one volt.

50 amperes at 100ft. gives circ. mils. = 100,000.
50 „ „ 50ft. „ „ „ = 50,000.
$\therefore d^2$ = 100,000 + 50,000 = 150,000 circ. mils. = No. 000 + No. 8 B. & S. gauge.

FACETIÆ.

Dreamt the Shock.—E. P. Roberts, of Cheyenne, Wyoming, got his boots wet one night, and touching a bare place on the Brush dynamo, got a shock in his arm that sent it out with a jerk like a ten-ton gun, almost dislocating it. That night he dreamt he had taken another shock, the effect on the muscles was the same, and his bedfellow got a bang which nearly knocked him out of bed, and awakened both of them.

Not that Kind of Switch.—We cut the following delicious note from a contemporary newspaper, where it is given as an item of news, and the remark is made in all good faith. "A man in the North of England has just had a patent granted him for an electric switch. The particulars are not given, but it looks as if the future of the small boy was very discouraging." The editor has evidently a more vivid and *tender* recollection of boyhood's days than knowledge of science in his manhood's prime.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

A COMMON PLATFORM.

The long and arduous labours that some individual members of the electrical engineering profession have undergone to obtain a business-like modification of the Act of 1882, have thoroughly imbued them with the idea that combination is necessary. The interpretation of the combination we refer to is one that has for its object the general business welfare of the profession, and not one that is instituted solely for the purpose of obtaining a virtual monopoly under the guise of free competition. Common interests require a common platform and collective action. Hitherto this common action has been obtained with great labour and difficulty. Probably no one outside the Brush Company's office, for example, will ever know the difficulties that have been encountered, and the labour gone through to overcome these difficulties, in order to obtain the modification of the Act above referred to. As each particular crisis has arisen in the development of the industry, it has become necessary for some one of the more prominent firms to take the matter in hand, feel, so to speak, the pulse of the profession, and obtain conjoint action to carry out the particular object in view. Especial difficulties have been experienced in all that pertains to parliamentary action, and thus when once the question of combination had been broached it commended itself to most of us; but, till quite recently, the best means of obtaining what was wanted was not self-evident. The history of the movement, so far as the technical journals is concerned, should be made quite clear. The original suggestion came from our contemporary, *The Electrical Review*. The suggestion, like many another good thing, was put foward too early, and found at the moment little support. After a time, the matter was brought forward again by the present writer, and subsequently *Electrical Plant* suggested the formation of an electrical branch in connection with the London Chamber of Commerce. This plan seems to have been thought the most feasible of all, and at the invitation of Mr. R. E. Crompton a large body of representative members of the profession met last Friday at the Holborn Restaurant, to meet the Secretary of the London Chamber of Commerce, and to discuss with him the best mode of procedure in order to obtain what is required. According to the explanations given at this meeting, in order to become a member of the Chamber of Commerce, the candidate must be nominated by a member, pay an entrance fee of two guineas, and an annual subscription of one guinea. If a sufficient number of members of any particular trade is enrolled, they can form a sub-section, governed more or less by their own bye-laws; of course, all through, being subject to the general laws of the Chamber and to the Central Council. The routine business of the section—as a section—is carried on by its own elected committee and officers.

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Members are not restricted to London, nor are the members of any one section restricted to the meetings of that section only, but can, on application, visit the meetings of any other section in whose proceedings they are interested. Here then, we find a fully organised society to hand, which offers all the advantages we require, and at less expense gives far greater facilities than could possibly be given by a newly formed and organised society. The special work of the section is the welfare of the trade it represents, while, as is easily seen, the collective work of the Chamber is the welfare of trade generally. It must be noticed that the organisation offered and desired partakes of nothing of the scientific character. We get enough, and perhaps too much, science at the British Association, the Physical Society, and the Society of Telegraph Engineers. The proposed section of the Chamber of Commerce will discuss the hindrances to trade, and the remedies to these hindrances; will be able to act quickly and effectively in future legislation, and especially will take cognisance of the duties collected by foreign nations, or by our own Government, upon the manufactured or raw material forming the staple of the trade. There are scores of questions which cannot be indicated here, but all of which influence the whole industry that can and will come under review. Sufficient arguments, however, have long ago been advanced to prove the necessity for such combination, and we have now endeavoured to emphasise and explain that a good opportunity offers for at once getting to work. The cry at the meeting was against further procrastination, and it is to be hoped that everyone will immediately join so that the committee may be elected if the number joining be too great for the whole to act as a committee, and thus the section get into working order. There is a pressing question that merits the collective wisdom of the trade. Rumours are rife that some enterprising firms from across the Atlantic mean to make a landing upon our shores, and hope to get a good deal of the trade of the immediate future. If these firms obtain a footing here and are successful in their competition, it will show that something is wrong somewhere when those on the spot, possessing equal facilities, cannot command the market. At the present moment no doubt such remarks may savour of selfishness; but we ask, what is is the use of trade combination if it is not to help to keep our home trade, and to get as much export trade as the conditions of competition will allow? The suggested combination, however, presents nothing but good features, and deserves the hearty support of all engaged in the industry. The time, when it is proposed, is most opportune, happening just when there seems to be a decided revival in the purely business prospects, and, should the promise be fulfilled, there will constantly arise questions of common interest which could beneficially be discussed and decided by such a section of the Chamber of Commerce.

STILL AN INFANT.

Elsewhere we give a report of the meeting of the Bath local authorities to consider the question of introducing the electric light into their city. It will be noticed that one of the arguments used against the introduction of the light is, "that it is now in its infancy." This argument is used by men all over the country, and we think the time has come when every opportunity should be taken by those interested in the progress of the light to combat the fallacies included in the argument. The men who talk in this fashion do not know what they are talking about. They get hold of a catch phrase which sounds well and means anything, without themselves attaching any specific meaning to it. Did the dye works reject the use of aniline dyes because they were recent discoveries of Perkins?" Did they not rather test them to see if they were as good as they were said to be, and finding them so continued to use and extend the use? In the early days of steam locomotion, if the world had waited for perfection the world would have been waiting still. No doubt objections were taken because of the infancy of the system, the desire to get rid of steam and smoke. The opponents wanted noiseless aerial carriages, always available, and, of course, costless. Now, we do not deny that improvements can and will be made in electric light apparatus, but from many points of view the possible improvements do not mean much. If we consider the generator, that is the dynamo machine, a large number of makers will even now guarantee a commercial efficiency approaching to ninety per cent. In other words, a hundred mechanical horse-power put into the dynamo results in 90 more or less e.h.p. given out by the dynamo. It is impossible to conceive a machine of this kind in which there shall be absolutely no loss, and if we are now in the infant stage we hardly see how the adult stage can be so very much better. We may take it for granted, then, that waiting will neither give us better engines nor better dynamos. The Bath authorities were discussing an overhead system of distribution and lighting by means of arc lamps. These are the simplest and cheapest forms of distribution and obtaining light that are known, and it is difficult to see where material improvements in these directions are to come in; at any rate, waiting for the adult stage to be reached, if it is not yet reached, can only result in reducing the cost fractionally. Then there is the old argument, Oh, you must not have the electric light, because if you touch the wires it certainly provides work for the coroner. Is it any more necessary to touch wires than it is to hunt for a gas escape with a lighted candle? Besides

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the wires should be out of reach and could not possibly be touched accidentally. These are the terms in which those who oppose the introduction of the electric light are apt to speak. Fortunately, in the case of Bath such counsels do not prevail, but there are other places where opposition carries the day and succeeds by means of these arguments which, when examined, possess neither rhyme nor reason. We are glad to be able to state from a telegram just received that the supporters of the electric light scheme for Bath have succeeded in their purpose, and that the tender of Mr. Massingham has been accepted. The system to be adopted is the Thomson-Houston, which has proved so satisfactory at Taunton. It is to be hoped that a little more experience with the light will cause a change of opinion as to its infancy. Opposition on the ground of economy can be understood, and so far as street lighting with arc lights and overhead distribution is concerned can easily be controverted. When our streets are properly lighted at night, someone will wonder why semi-darkness was so long tolerated. More and better light saves both time and money. More work can be done in a given time with a good light, locomotion is easier and quicker, so that the saving indirectly, even if there is none directly, can hardly be of small proportions. Yes, the infancy stage has passed; the light is scientifically and commercially successful, and now that certain legislative disabilities have been removed, it remains only to give confidence in its capabilities to the various authorities throughout the country in order to obtain a large increase in its use.

CORRESPONDENCE.

VALVE-GEAR TO COMPOUND ENGINES.

To the Editor of The Electrical Engineer.

Sir,—With reference to your issue of the 20th instant (page 52), which contains a notice and illustration of our 12-h.p. Robey engine exhibited at the Nottingham Royal Show, we beg to point out that there is a slight error in your description, wherein you say, "though usually, we believe, they are fitted with the Proëll gear."

As a matter of fact, our compound Robey engines are all fitted with link expansion gear, controlled by Richardson's patent spring governor.

We have some time ceased manufacturing the Proëll gear, except when specially ordered; our new trip-gear, as exhibited at the Royal Show, possessing many advantages over the former, and lending itself better to be controlled by electricity, for which purpose it was specially designed.—Yours, &c., Robey and Co.

HOT BEARINGS.

To the Editor of The Electrical Engineer.

Sir,—Referring to Mr. Broadbent's (?) letter in your last issue may I ask whether bearings of either fast or slow engines, &c., of any sort get heated? If not, then there is no necessity for a detector. But if, as I have good reason to believe, hot bearings are a frequent source of trouble, there is ample demand for simple apparatus which gives timely warning (without requiring attention) as supplied by Messrs. Elliott Bros.

True, hot bearings, like many other things, *ought* not to occur, but they do; and although Mr. Broadbent may not allow any under his charge, yet all engineers are not so careful.—Yours, &c., W. T. W. Thackeray.

Aldeburgh, July 25.

RE THE ELECTRIC INCANDESCENT LIGHT PATENT CASE.

To the Editor of The Electrical Engineer.

Sir,—Referring to your article of the 20th inst., let me ask you and your readers whether it is not quite sufficient to prove "commercial success" to show success on even the smallest scale—that is, that the patent was calculated to benefit even the smallest section of the public. For instance; if the patentees, Messrs. Swan and Edison, can show that a few noblemen and others possessing valuable libraries or picture galleries would have been benefited at even a considerable outlay by adopting the electric light in place of gas, which produces such irremediable injury to books and paintings, I ask you whether the claim that the lamp "could have become commercially successful" would not have been sustained by the facts?—Yours, &c.,

24th July, 1888. H. A. K.

TRAMWAY WORK.

A correspondent writes, and among other things desires information upon the following points:

First, the exact data as to when the first electric car was run in England or on the continent by the aid of storage batteries.

Secondly, how the storage batteries were inserted in the car, whether through the outside panels of the car or through the end thereof?

THE LUGO MOTOR.

In discussing the various methods by which motion can be obtained with combinations of magnets and wires carrying currents, Faraday, in his "Researches," remarks that "the motion between two poles and two dissimilar wires (helices) is an instance where several powers combine to produce an effect." It is upon this principle that Dr. Orazio Lugo, of New York, has constructed an electric motor which embodies a novel principle which seems destined to a wide application.

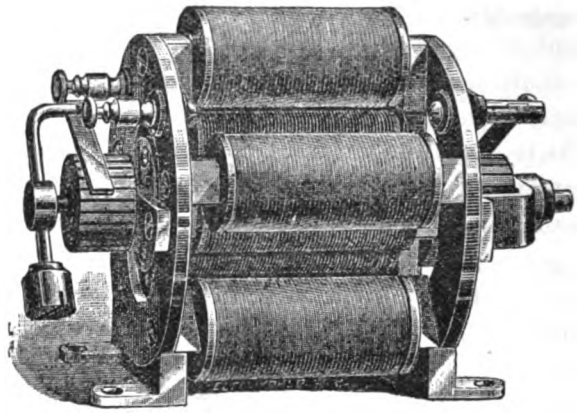

Fig. 1.—The Lugo Motor.

The new motor of Dr. Lugo is constructed so as to utilise the maximum effects found in placing moving solenoids in proximity to fixed solenoids in such relation that, as the armature coils move, a maximum number of lines of magnetic forces is cut in the passage of each armature bobbin past each field-magnet bobbin, and these effects are made successive, so that there is a continued application of such successive effects. And, in addition to utilising these effects, due to a specified relation of the solenoids themselves, the combined effects of these solenoids and their cores also are employed.

By creating such successive magnetic circuits through successive armature and field bobbins in pairs until the series has been gone through once in each complete revolution of the armature, each armature bobbin being in circuit

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at least once in a complete revolution with each field-magnet bobbin, and all of the bobbins, both of the armature and field-magnets, being allowed to rest magnetically by being cut out of circuit during a fraction of each revolution of the armature, the evils effects of Foucault currents are said to be largely avoided.

The motor, which is of very simple construction, is shown in perspective in Fig. 1 and in cross-section in Fig. 2. As will be seen, it consists of a series of bobbins arranged in a circle to the number of five, and within which there revolve four similar bobbins attached to the shaft of the motor. All these bobbins are provided with cores and short pole-pieces, which revolve in close proximity to each other.

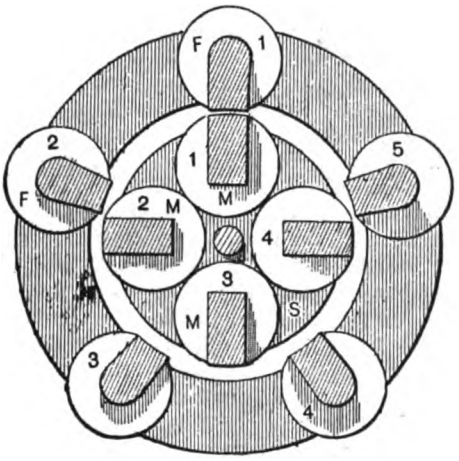

FIG. 2.

The revolving armature coils are connected to a commutator fixed to the shaft, upon which bears a stationary brush, B^1, shown in the end view, Fig. 3. The connections of the individual armature bobbins to the commutator are seen in Fig. 4, which shows also the cross-connection between the commutator strips. The other side of the armature shaft carries a revolving brush, which bears against a fixed commutator to which the field-bobbins are connected. Finally, Fig. 5 shows the circuits diagramatically, with the bobbins laid side by side, and showing the manner of their connection one with the other.

It will now be readily understood that if a current be passed through the armature and field-bobbins M^2, F^2, the pole-pieces are in such a position as to cause M^2 to be attracted to F^2 and cause rotation in the direction of the

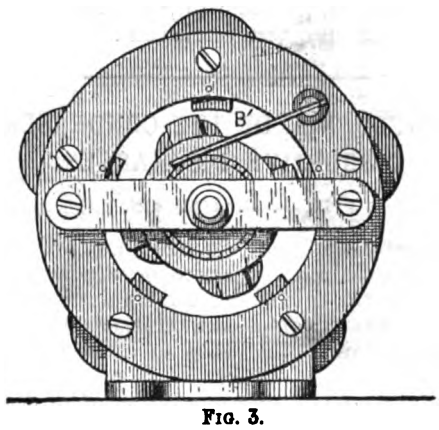

FIG. 3.

hands of a watch. This attraction continues until the pole-pieces M^2, F^2 have arrived exactly opposite each other, or in the position in which M^1, F^1 is shown. At this instant, however, the current is shifted to the bobbins M^3, F^3, which will then have arrived at the relative position formerly existing between M^2 and F^2, and the magnets act in succession, as follows: M^4, F^4; M^1, F^5; M^2, F^1; M^3, F^2; M , F^3; M^1, F^4; M^2, F^5; M^3, F^1; M^4, F^2; M^1, F^3; M^2, F^4; M^3, F^5; M^4, F^1; M^1, F^2; M^2, F^3; M^3, F^4; M^4, F^5, and back to the starting point M^1, F^1.

Thus, in every revolution of the armature shaft, each armature coil is placed in circuit with each field coil; and, there being four of one and five of the other, it follows that there are twenty successive pulls at as many radial positions of the shaft, each pair of coils being in circuit successively only during one-twentieth of a revolution of the shaft. It will be noticed that the stationary commutator is divided into four groups of segments, five in each group, while the rotating armature is divided into five groups, each of which has four segments. An examination of the circuit will show the commutation of the four armatures and five field bobbins. It is evident, however, that any desired number of field and armature bobbins may be combined, it being only necessary to so commutate the circuits as to make the effect of the magnetic pull on the bobbins successive in its action.

With a motor constructed in the manner just described, Dr. Lugo claims to utilise the power due to the attraction of the pole-pieces of the armature and field-magnet bobbins

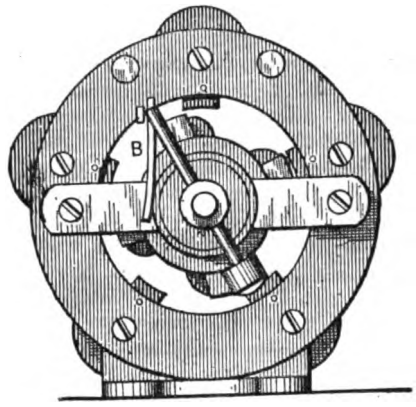

FIG. 4.

as well as that due to the parallelism of the windings of the bobbins as they approach each other during the rotation of the armature, thus obtaining an increased effect from those magnetic lines of force which are ordinarily radiated to create reverse inductive effects detrimental to the efficiency of the machine.

The arrangement is also claimed to avoid the evil effects due to self-induction, for the reason that only a minimum amount of effective wire is in circuit at any time, and that

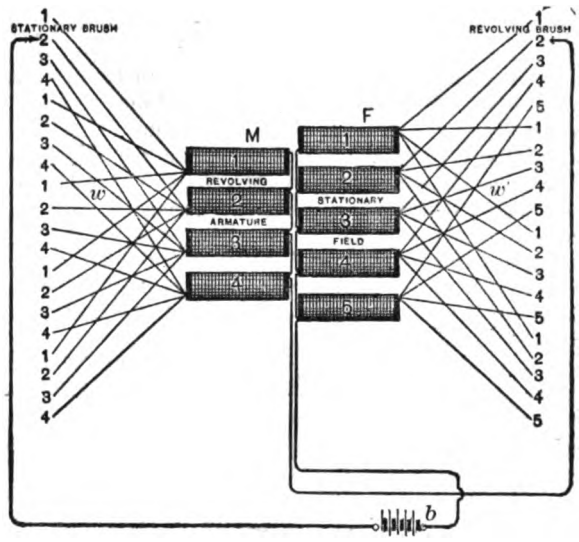

FIG. 5.

only at the time when it is needed to give the best effects. By creating the effective field and armature circuits at stated intervals and only when needed, and permitting all of the field or armature bobbins to rest or be magnetically or electrically discharged at different portions of the armature rotation, heating and waste of energy is said to be prevented. The Foucault currents are also reduced to a minimum by reducing the effective field and armature circuits with their magnetic cores to a minimum while obtaining their maximum effect. The sparking at the brushes is likewise avoided by reason of the fact that there is no magnetic lead in the field or armature, inasmuch as the field travels around just in advance of the armature as each bobbin is cut in

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Among other novelties which the machine is claimed to possess by the inventor is, that both field and armature circuit are conjointly cut out at different points in the rotation of the armature, thereby utilising only that portion of the combined circuit which is needed to propel the motor or create a current in the machine when used as a dynamo.

The efficiency of this motor is said to be very high, and the machine very light and simple in construction.—*Electrical World.*

THE ADELPHI INSTALLATION.

Among the first to show their belief in the electric light and to act upon that belief were the Messrs. Gatti, who have now one of the largest private installations in the kingdom. It will be remembered by many *habitués* of London that the restaurant almost opposite Charing Cross was one of the first places wherein electricity superseded gas, and so successful has the lighting been considered by the proprietors that they have introduced the system into the Adelphi Theatre, in which, as soon as the installation is complete, gas will become an illuminant of the past. At the invitation of Mr. Blackburn, M.I.C.E., resident engineer to the Edison and Swan Company, by which company the installation has been carried out under Mr. Blackburn's superintendence, we witnessed the lighting, on the reopening of the theatre on the 19th inst., where not only was the new light first introduced, but it was the first night of a new play, "The Union Jack." Under such conditions the responsibility upon the shoulders of the electric light contractors was exceedingly onerous. Not the slightest hitch or difficulty of any kind occurred, and this again in spite of the unfinished state of the installation, many of the details and connections being of a temporary character, as it was not expected that the light would be required at so early a date.

The generating plant, sufficient for 4,000 incandescent lamps, has been supplied by the Edison and Swan Company, and is placed in a building below the street level at Bull Inn-court, adjacent to the theatre. The Adelaide Gallery, the Strand Restaurant, and other buildings are also to be supplied from the same source.

The plant comprises three 150 h.p. Babcock and Wilcox safety-tube boilers, working at a pressure of 140lb. The engines are four of Messrs. Willans and Robinson's double centre valve compound high-speed engines, two of 75 i.h.p., and two of 130 i.h.p. We should like to interpolate a suggestion here in regard to information relating to these engines. In March, this year, Mr. Willans' read a paper before the Institution of Civil Engineers, which was discussed at great length. The paper, and the discussion thereon, contains some of the most valuable information that has ever been contributed on this subject, and as Willans' engines are being so largely used for electric light purposes, we should strongly advise all who can obtain a copy to read the proceedings of the Institution containing the paper referred to. The engines are coupled direct to four Edison-Hopkinson dynamos, two for an output of 105 volts 800 amperes at 425 revolutions, and two for an out-put of 105 volts 475 amperes at about 475 revolutions. The armatures are of the bar type, and the magnets are exceedingly massive, those of the larger machine weighing nearly six tons.

The four sets stand on one solid mass of concrete 6ft. thick, and there is a very marked absence of noise and vibration.

It is anticipated that a very economical result will be obtained, and already at a preliminary trial at Messrs. Willans and Robinson's works, an electrical h.p. (746 watts) in external circuit was obtained from 30lb. of steam per hour, and a return of 82 per cent. of the i.h.p. These results were obtained with comparatively wet steam, and as great precautions have been taken to supply dry steam, still better results should be obtained in practice.

The external circuits will be 12 in number, and two large distributing boards of slate 6ft. 6in. by 4ft. 6in. have been provided. The connections take the form of large brass bars, which can be coupled by means of plugs, so as to make any number of combinations between the dynamos and circuits. In effecting changes sparking is avoided by shunting the plugs through a quick break-switch. The dynamos all work on independent circuits, and one dynamo is always held in reserve, and whenever it has to relieve another already at work any dip in the lights is avoided by first of all bringing it up to full load on a resistance, and then exchanging loads between the two dynamos by the reversal of a commutating-switch.

It is Messrs. Gatti's intention in the course of a few weeks to entirely dispense with the gas service throughout the theatre so far as lighting is concerned. About 1,500 lights are required to light the bars, passages, refreshment-rooms, auditorium, and stage. The auditorium is lighted from the dome by means of eight 200 c.p. Edison-Swan lamps. Ornamental 3-light brackets are suspended round the tiers, and single lights are provided for the occupants of the pit, gallery, and boxes. Duplicate circuits have been provided throughout, and great precautions have been taken with a view to secure absolute safety from fire or possible extinction of the light. The lamps for the floats (footlights) and battens are provided with collars of a special form, each carrying its own cut-out, and having extended terminals making contact directly with the main wires, which are completely enclosed in a slate casing, and on which also the lamp sockets are mounted, proximity of any combustible insulating material to parts developing heat is thereby entirely avoided. All the other conductors about the stage are enclosed in wood casing. They are strongly insulated with indiarubber, and further protected by a sheathing of asbestos tube, and in all places where there is any liability to injury by violence, or by nails being driven through the casing, a lining of sheet-iron is provided.

Lamps of high candle power have been introduced in the construction of the variable resistances required for scenic effects; and it is also arranged to display colour lights when required. As we say, the installation was hardly in its normal state, and when the finishing touches have been given we intend to illustrate the dynamo-room, showing the arrangement of boilers, engines, dynamos, and switch-boards. It hardly comes within the province of an electrical engineer to criticise a theatrical performance, but as all the scribes whose work is of this special description spoke highly of the play, we may add our testimony in the same direction, saying play and performance were good, with this addition, that one of the principal actors is stated to have said that the electric light is far better than gas in every respect, and having once got it they intend to keep it. Too great praise cannot be given to the Edison-Swan Company and to Mr. Blackburn for the admirable manner in which this work has been carried out.

THE INFLUENCE OF THE CONDENSER ON DISRUPTIVE DISCHARGES.

BY E. G. ACHESON.

While investigating some troubles in an arc-light circuit recently, I was led into a series of experiments on the subject forming the title of this communication; and, while the method of experimentation was rather crude, the results obtained are, I think, of a value sufficient to warrant my presenting them to the public.

For the experiments a direct current of an E.M.F. suitable for the work was not at hand, so an alternating one was used, connections being made to the street mains of an electric light plant, the E.M.F. on the circuit being 1,000 volts.

A special transformer was used, having five terminals, the primary forming a portion of the secondary circuit. One of the terminals was connected direct to one side of the experimental working circuit, while by means of a switch, either one of the other four could, at will, be connected to the other side of the circuit. By this arrangement four E.M.F.'s could be had as desired, and, for convenience of expression, I will term these different connection circuits, and number them 1, 2, 3, 4, in the order of their E.M.F.'s.

In order to determine the E.M.F.'s of these circuits, I made a series of 50 measurements of each, using Law's

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method for direct currents. The condenser was made of a plate of glass with tin-foil on each side, and was found to have a capacity of ·00282 microfarad, and answered admirably for the work.

The condenser being placed in the circuit, would, upon opening the circuit by mean of a key, hold a charge of a value dependent upon the potential of the terminals of the transformer at the moment of opening, and by suitable connections this charge could be discharged through a galvanometer and its exact value determined.

This operation of charging from the transformer, and discharging through a 10,000 ohm mirror galvanometer, was repeated fifty times for each of the four circuits. Of the fifty determinations of the E.M.F. of each circuit, the highest value obtained was assumed to be the true one for its circuit.

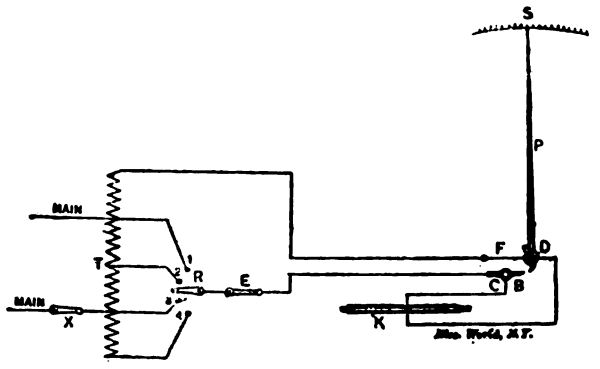

FIG. 1.

By this method I found the four circuits to have the following E.M.F.'s:

Circuit No. 1	.....	580 volts.
,, No. 2	.....	1,110 ,,
,, No. 3	.....	1,690 ,,
,, No. 4	.....	2,114 ,,

The transformer was built for 2,000 volts, with 1,000 volts in the primary circuit. My results showed a little over that amount.

Having now the data necessary for plotting the E.M.F.'s of the circuit, work was directed to the measuring of the spark lengths and the investigation of the influence of the E.M.F. and condenser on them.

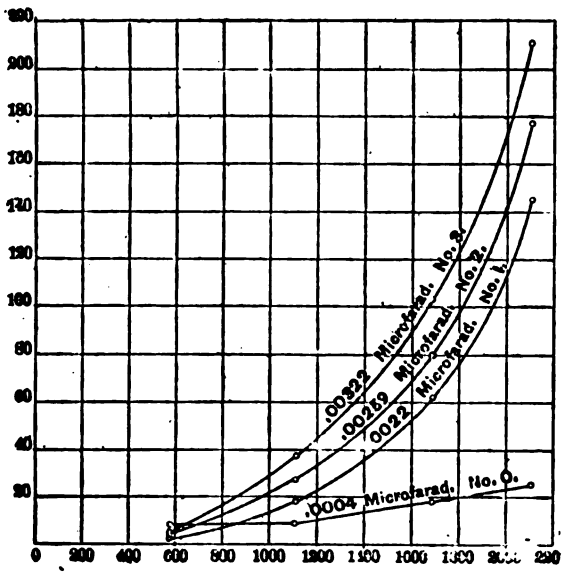

FIG. 2.

Three condensers were made as before described, and carefully measured. The capacities were:

Condenser No. 1	.....	·0018 microfarad.
,, 2	.....	·00219 ,,
,, 3	.....	·00282 ,,

The working circuits without a condenser were found to have a capacity of ·0004 microfarad, and when working up the measurements this capacity was always added to that of the condenser used.

To measure the spark lengths an arrangement of apparatus was used (as shown in Fig. 1), in which A and B are two points, mounted in the posts C and D, the latter being made so as to turn upon its centre. P is a pointer attached to D, S is a scale, T is the transformer, R is a switch for connecting up either one of the four circuits, E is a switch used for opening and closing the experimental circuit; F is a fusible wire connection to protect the transformer, K is a condenser, and X a switch for opening the main line.

The relative distances from D to S and A were as 15 to 1, and the scale was graduated so that a movement of the

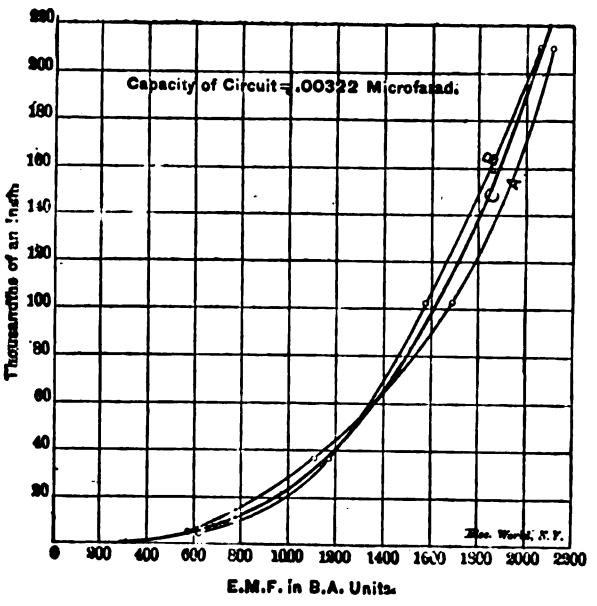

FIG. 3.

pointer over one division moved the point A one one-hundredth of an inch; but owing to the size of the graduation a movement of one one-thousandth of an inch could readily be detected.

The mode of operation was to first set the points so as to just touch each other, and note the reading of the scale; after which the post D was swung upon its centre sufficient to draw A from B such a distance as to prevent a discharge

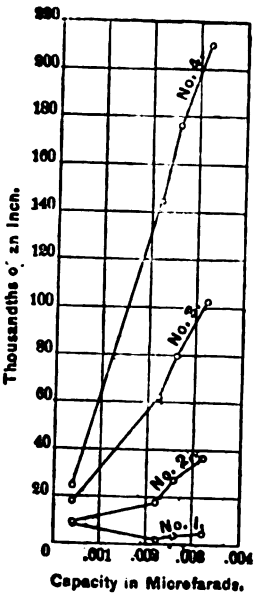

FIG. 4.

occurring across the intervening space upon opening and closing the switch E fifty times. A was then caused to approach B by steps of one one-thousandth of an inch, fifty ruptures of the circuit being made after each advance. When a discharge occurred, note was made of the scale reading, and the difference between it and the first reading was used as a measure of the spark length. The true distance between the points would, of course, be the chord of the arc described by the point A; but the distances were

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so small that this error was neglected, and the distance measured on the arc. When a condenser was used, it was connected up between the posts C and D, as shown in the figure.

Measurements were made with this apparatus of the spark length produced for each circuit, first without a condenser, and then with each of the three condensers, successively connected to C and D. The results obtained for the various conditions were :

Circuit.	Spark lengths in inches. 1.	2.	3.	4.
Condenser No. 0	·008	·0085	·018	·025
Condenser No. 1	·002	·018	·062	·145
Condenser No. 2	·004	·027	·080	·177
Condenser No. 3	·005	037	·103	·211

Fig. 2 shows the results obtained, plotted as curves, each curve being numbered the same as the condenser used to produce it, No. 0 being the curve determined without a condenser.

In Fig. 3 I have plotted the curves by laying off the capacity of the circuit horizontally, and, as before, representing the length of the spark by the ordinates. The four curves represent the four circuits, and are numbered accordingly.

To determine whether the E.M.F.'s were influenced by a discharge from the magnetic field of the transformer they were remeasured with a condenser having a capacity of ·00077 microfarad. If a discharge occurred, the increase of the E.M.F. above the true value would be proportional to the discharge, and the latter would be subject to the amount of current on the circuit. Hence by decreasing the capacity of the condenser, a lower E.M.F. would result.

The E.M.F.'s as measured were :

Circuit No.	1	625 volts.
,,	2	1,176 ,,
,,	3	1,580 ,,
,,	4	2,058 ,,

The E.M.F.'s of the first and second circuits are higher, and those of the third and fourth are lower, than those obtained with the larger condenser ; but the differences are not greater than would be expected under the circumstances, and, as will be seen from the curves produced, their relations are such as to leave no ground for assuming a discharge from the field.

I would mention that while the first set of E.M.F.'s was determined when the machinery in the laboratory and surrounding neighbourhood was in motion, the second set of E.M.F.'s was measured under the most favourable conditions, the machinery being motionless. In Fig. 4 I have plotted two curves, A and B, in each of which the ordinates represent the length of the spark, and the abscissæ, the E.M.F. in B.A. units.

The experimentally-determined spark lengths for each of the four circuits are the same in both curves, and are marked with circles.

Curve A was plotted from the E.M.F.'s as found with condenser No. 3 ; and curve B, from the results obtained from the small condenser having a capacity of ·00077 microfarad.

The curve C, in Fig. 4, is very nearly the mean of curves A and B, and was calculated by the following formula:

$$\frac{(\text{E.M.F.})^2 \times \textit{charge in coulombs}}{a} = d;$$

where a is a constant for the dielectric, and d the spark length.

The charge being equal to the E.M.F. multiplied by the capacity, the formula may be written—

$$\frac{(\text{E.M.F.})^3 \times \textit{capacity}}{a} = d.$$

In calculating curve C, 135 was taken as the value of a, and d was in inches, the formula then being :

$$\frac{(\text{E.M.F.})^3 \times \text{capacity}}{135} = \text{inches} = \text{length of spark in air.}$$

I am now engaged in determining the value of a for a number of dielectrics, especially those used for insulating conductors in cables, and at the same time experimental work is being done on the determination of the part the phenomenon plays in the operating of underground cables. *Electrical World.*

THE ELECTRICAL DISTRIBUTION OF TIME.*

BY ALLEN D. BROWN, COMMANDER U.S. NAVY.

The subject upon which I have the honour to address you this evening is the Electrical Distribution of Time. Leaving out of consideration the question as to what time is, what its measure and how obtained—questions the answers to which would of themselves serve as a subject for an evening's lecture—I will pass at once to a definition of the title which has been chosen for this address. By this title is understood the causing of the instant shown by a timepiece at a central station to be marked by some apparatus prepared to receive the necessary signal at another station in electrical connection with such central station.

If the apparatus at the receiving station is in the nature of a timekeeper, its operation must be automatic ; and to secure the highest possible accuracy the action of the central timepiece must likewise be automatic. In its best form, then, our title may be said to mean the automatic electrical synchronisation of one or more clocks by a clock at the central station. With this synchronisation may also be associated the registering of the signal upon a chronograph, the ticking of a telegraphic instrument, the firing of a gun, the ringing of a bell, the discharge of a flashing signal, or the dropping of a time ball. In a complete system any or all of these means will be used according to the circumstances of the case under consideration. It is essential, to insure the highest order of accuracy, that the central station shall always be at an astronomical observatory, and preferably at one which is able to devote the services of one or more persons to this special duty. Such work is known briefly as a time service, and its signals as time signals. A brief historical review of the evolution of the time service of to-day will not, it is hoped, prove uninteresting.

As early as 1816, one Ronalds, an Englishman, invented a telegraph which was so dependent upon timepieces for its working, that it may be said to have been a device for the temporal distribution of electricity. He connected two clocks with some 500ft. of insulated copper wire ; upon the seconds arbor of each clock was placed a circular plate of brass, the circumference of which was divided into twenty equal parts, the chief letters of the alphabet and a double series of numbers up to ten being placed in these divisions. In front of this was a second plate in which was an opening through which one letter and figure were visible ; in front of this latter plate was suspended a pith-ball electrometer connected with the wire between the two clocks and also with a frictional electric machine ; this apparatus was in duplicate, one for each end of the line. An electrical pistol was also in circuit when the apparatus was not in use, so that by its discharge the attention of the attendant would be attracted when desired, The manner of using this telegraph was as follows : The clocks were first supposed be accurately synchronised, so that the same letter would appear at the same instant in both plates ; the machine was turned, and by the electricity thus generated, the pistol at the other end of the line was discharged ; the attendant in reply made a signal previously agreed upon, by waiting until this prearranged letter was in sight, and then turning his machine, when the charge would cause the pith-balls of the electrometer to diverge at both stations ; the first operator would cause the discharge of the machine by a touch, the pith-balls would fall together ; the message would then be sent in like manner, as each letter came in sight through the hole in the upper plate, the receiver noting each letter as the balls fell. There were two difficulties in the way of the use of this plan : (1) that of obtaining a current at all times ; (2) the fact that it would be impossible to keep the two clocks always exactly together. This, however, could easily have been gotten over, as the sender could signal when a certain letter was visible, and the receiver noting the one he saw could then tell how much his clock was out of the way. In effect this was the first attempt at telegraphic time signals, and for this reason only is it here referred to.

In 1833 the German mathematician, Gauss, associated with Weber, erected a line of telegraph some five miles in

* *Proceedings*, Franklin Institute.

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length, connecting the astronomical and magnetic observatories in Gottingen with various other stations. He obtained his current from a crude form of magneto-electric or dynamo machine, and the whole apparatus was of a very unwieldy character; a flattened coil containing some 30,000 feet of iron wire had suspended within its centre a magnetised bar weighing some 30 pounds; upon the suspending wire was arranged a mirror in which was reflected a scale, the latter being viewed through a magnifying-glass.

The dynamo had a pole changer, so that the current could be sent in either a positive or a negative direction, and thus the bar be deflected either to the right or the left, at the will of the operator; by a combination of these deflections a message could be spelled out. By this apparatus, as I have gathered, comparisons of clocks were actually made, and to these gentlemen is therefore due the honour of sending the first telegraphic time signals. Although no particulars of the way in which this time service was operated are on record, it may easily be surmised that the method was somewhat as follows: Probably the hour selected for the signal was noon; two or three minutes before that hour, by the standard clock, a signal would be sent over the line; as the hands of the clock marked the exact hour, one distinct deflection of the bar would be made, at which instant the receiver would note the time shown by his clock; subsequently ascertaining the error of the standard, that of the other would readily be deduced.

In 1840, Mr. Charles Wheatstone announced the invention of an apparatus "enabling a single clock to indicate the same time in as many different places, distant from each other, as might be required." He proposed to accomplish this object by connecting electrically a standard clock with his *electro-magnetic clock*, which latter consisted "simply of a face with its second, minute and hour hands, and of a train of wheels which communicated motive-power from the arbor of the second hand to that of the hour hand in the same manner as in an ordinary clock train"; a small electro-magnet was caused to act upon a peculiarly-constructed wheel placed on the seconds arbor, in such manner that whenever the temporary magnetism was either produced or destroyed, the wheel (and, consequently' the second hand) advanced the sixtieth part of its revolution. On the axis of the scape-wheel of the primary clock was placed a small disc of brass, which was first divided into sixty equal parts; each alternate division was then cut out and filled with wood, so that the circumference consisted of thirty alternations of wood and metal. A very light brass spring was secured to an insulator attached to the clock frame, its free end pressing upon the circumference of the disc; connection having been made between the insulated end of the spring and one end of the wire with which the electro-magnet was wound, the circuit was completed by the other end of the wire being connected to the clock frame through a battery; the primary clock being running, it followed that the circuit was made and broken each alternate second, while the distant dial recorded the advance of its wheel in unison with that of the parent clock. This is practically the same thing as the so-called electric time system of the present day, and it was the first attempt at the distribution of time by electricity. It had the defect common to all such systems, of being applicable to only a limited space, and, in addition, it was subject to the same trouble that besets everyone who proposes to rely upon electricity derived from a battery as a motive-power for any sort of machinery; accidents *will* occur, and a system of time distribution on this plan an accident is fatal to precision.

The completion of the Morse telegraph between Washington and Baltimore, in May, 1844, afforded the means for the next step in the evolution of our subject, and for this we are indebted to a naval officer, Commander Wilkes (afterwards Rear-Admiral), who, associated with Lieut. Eld, transmitted time signals between the two cities. So keen was Wilkes in this matter, and so alive to its importance, that although the telegraph was not completed until the 27th of May, yet on the 9th of June Wilkes was exchanging his first signals, completing his work on the 12th. He used two chronometers, each rated to local time, and thus ascertained the difference of time between the two cities, and hence the difference in their longitude; his determination of this difference was only 3-100 second from that subsequently determined by the Coast Survey when more accurate methods had been devised.

Two years later, in October, 1846, time signals were exchanged between the Naval Observatory, in Washington, and the observatory of the Central High School, in Philadelphia, this being the first use of what has since come to be known as the American telegraphic method of determining differences of longitude. This work was planned under the Coast Survey by Mr. Sears C. Walker, an assistant in that office. The observations were made by Prof. Kendall, in Philadelphia, and Lieutenant Almy, in Washington.

In July and August, 1848, signals were exchanged between the observatory of Harvard College and a private observatory in New York. During this work, Prof. Bond, of Harvard, conceived the idea of an automatic circuit interrupter to be worked by the clock used in the observation. He communicated his ideas to the superintendent of the Coast Survey, and by him was authorised to construct a clock after his plans. This work was not finished until some time in 1850.

In the meantime Mr. Walker, in conversation with Prof. O. M. Mitchell and Dr. John Locke, of Cincinnati, had told them what the Survey desired in the way of an automatic registration apparatus. Both these gentlemen set at work, and Mitchell devised an apparatus which was finally completed in February, 1849. Locke busied himself in the same direction, and twelve days after his talk with Walker he had perfected his apparatus. In this, each of the 60 teeth of a wheel on the seconds arbor of a clock struck the arm of a tilt hammer. When the tooth was in a horizontal position, the other arm of the hammer fell upon a bed of platinum, which was in connection with one pole of a battery, while the fulcrum on which it moved was in connection with the other pole. The circuit was then broken and made at each rising and falling of the hammer. The next step was to connect the clock with some form of registering apparatus, and for this purpose the ordinary Morse register, with its continuous fillet of paper, was used. On the 17th of November, a little more than three weeks after the idea was first suggested to him, Locke had in operation his clock registering its beats over the entire line between Cincinnati and Pittsburgh, a distance of more than 400 miles.

This was the first instance in which time signals were delivered *automatically* by telegraph. As the fillet of paper passed through the register, a continuous record of the seconds was made, with nothing, however, to indicate the beginning of the several minutes; this indication was accomplished by the use of a break circuit key which the observer held in his hand, and pressing at the sixtieth second of each minute, caused the registration to cease for three or five seconds, as might be desired, thus marking the beginning of the minutes. Presumably, Locke was engaged during the following six weeks in perfecting his invention, for it was not until December 30th that he announced to Lieut. Maury, the superintendent of the Naval Observatory, what he had accomplished, and offering it, not only for the telegraphic determination of longitudes, but also "as useful in a local observatory as a faithful and convenient register of observations." On the 5th January, 1849, Maury replied in substance as follows: "I regard it as one of the most important inventions of the age. Feelings of professional pride gave additional zest and warmth to these congratulations. For ages the problem of longitude has occupied the mind of wise men, and commanded the attention of governments. This discovery of yours is the crowning work in the great problem. Permit me to claim this high honour first for my country, and next for the Navy. An American naval officer, Captain Wilkes, was the first to apply the magnetic telegraph to the practical determination of longitude. It greatly lessened labour and refined results. The next and last step has been made by yourself, who also are an ex-officer of the Navy. You have, by your invention, eliminated from the problem the errors arising from comparing the face of one clock with that of another, and made it as easy and practicable to divide seconds into hundredths, as before it was to divide minutes into seconds.

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By your invention you enable the astronomer to make the ticks of his clock here in Washington to be heard wherever the telegraph leads, and you make the clock to divide those seconds into hundredths."

On the same day he addressed a letter to the secretary of the Navy, informing him of Locke's invention, and recommending it in the highest terms. This letter was made public, and after some further correspondence it was followed by an invitation from the secretary to Locke to come to Washington. The subject of an appropriation was discussed, and after much push on Maury's part, the sum of 10,000dols. was put in the Naval Bill by the House for the purchase of a clock on Locke's plan. This came very near being lost in the Senate, but it was saved by the exertions of the friends of the measure, and became a law on the 3rd of March. By the provisions of the Act the clock was to be erected at the Naval Observatory. This was done, and on the 7th of December, 1849, the clock, with the chronograph attachment, was used for the first time, and proved to be a great advance over the old method, although there was still some difficulty in the matter of accurate registration.

As before stated, in 1850, Prof. Bond, of Harvard Observatory, completed his clock for the Coast Survey, and, in addition, invented an improved chronograph in which the paper was placed upon a revolving cylinder, the driving power of which was so adjusted as to cause one revolution per minute to be made, the record being made by a pen in a continuous spiral line; but, as in Locke's plan of the Morse fillet, there was no means of noting the beginning of each minute automatically. About the same time the cylindrical form was under consideration at Washington, but there were some difficulties which it does not appear were surmounted at this date.

In 1851, the Bond chronograph, with its ingenious driving machinery, known as the spring governor, was taken to England, and there exhibited, eliciting much commendation, and receiving a gold medal at the Great Exhibition of that year. The Astronomer Royal, of the Greenwich observatory, in his report for June, 1851, states that he has adopted the plan of "making a galvanic register of transits in the American manner," but the cylindrical chronograph was not adopted until some three years later—a suggestion by Maury during a visit to Greenwich having enabled Sir George Airy to overcome the practical difficulties which were encountered.

During this same year the observatory at Harvard was connected with the various telegraph lines from Boston, as many longitude operations were being carried on for the Coast Survey. In this manner the attention of such portion of the public as were interested in such matters was drawn to the practicability of obtaining accurate time from the observatory, and in many cases regular arrangements were made for the transmission of the signals throughout Massachusetts and some of the other New England States. Indeed, at present the time service of Cambridge furnishes the chief source of comparison in that section of the country; the observatory at Yale College also possesses such a service, which supplies Connecticut in like manner. The observatory of the Washington University at St. Louis, and that at Alleghany, Pa., also have extensive time service, and there are others covering less ground.

At Washington the Naval Observatory has dropped a time ball since the first occupation of the completed buildings in 1844, following the example set at Greenwich eleven years earlier. At first the dropping was done by hand, upon signal received from the chronometer room; later this signal was sent electrically, and the dropping of the ball was performed automatically by the same signal. This ball served to give the moment of noon not only to the cities of Washington and Georgetown, but also to the Navy Yard and to such vessels as happened to be lying there. No telegraphic signals were transmitted, however, for several years, the Royal Observatory at Greenwich far outstripping us in that respect, as a system of time signals to the important cities and towns of England was in operation as early as 1852. This, of course, was readily accomplished in a country of such small extent, where the difference of any given local time from that of Greenwich is not great; but in our own case, the great extent of longitude and the different local times through what was supposed to be the necessity of the case, conspired to prevent the extension of any such system. Local jealousies had also a part to play, as the railroads running out of Boston would not keep New York time, and *vice versâ*.

With this brief retrospect of the course of events which has made the electrical distribution of time possible, let us return to the subject proper of this essay; and in so doing I beg leave to repeat a portion of the definition with which it began—viz., "By the electrical distribution of time is understood the causing of the instant shown by a timepiece at a central station to be marked by some apparatus prepared to receive the necessary signal at another station in electrical connection with such central station. It is essential, to secure the highest order of accuracy, that the central station shall always be at an astronomical observatory, and preferably one which is able to devote the services of one or more persons to this special duty." In order to a fuller understanding of the functions of an observatory, it will be necessary to call your attention to some of your early instructions in astronomy. The interval between two successive transits, or meridian passages, of the sun, is an apparent solar day; owing to the unequal motion of the earth in its orbit (or to put the statement in another form, to the apparent unequal motion of the sun in the ecliptic) two successive apparent days are not of the same length. As a constant standard of time is necessary, it has been found essential to assume an imaginary sun moving in the equinoctial (or the plane of the earth's equator) at a uniform rate, which is the mean rate at which the true sun moves in the ecliptic; the interval between two successive transits of this imaginary mean sun is a mean solar day, and in a clock keeping mean time, the hands would (if the clock were correct) point to 12h. 0m. 0s. at the instant of transit, which is known ordinarily as noon. As a matter of fact, however, the sun is rarely used at observatories for the determination of time, but stars are employed instead; this is done, not only because the tables of the positions of the stars are more accurate, but because several stars can be observed at about the same time, and the results deduced from these observations made to serve as checks upon each other. The interval between two successive transits of the same star is called a sidereal day; this interval is constant, and is (like the mean solar day) divided into twenty-four hours. Each star comes to the meridian at an earlier period than on the day preceding, if the transit be noted by a mean-time clock; the difference between a star and a sidereal day is 3m. 56s.—and hence the sidereal 0h. is constantly getting ahead of the solar 0h., so that it is always necessary to reduce the *sidereal* time found by the star observations to that used in ordinary life, or to *mean* time. The positions of stars are given in the tables by their *declination* (similar to terrestrial latitude) and their *right ascension* (similar to terrestrial longitude); the right ascension of the star being reckoned from the celestial prime meridian, it follows that when any given star crosses the meridian, the sidereal clock should show the time given in the table as the right ascension of such star; the difference between the time actually shown by the clock and this right ascension is the error of the clock; comparing then the time shown by the sidereal clock with that shown by the mean time clock, we find the error of the latter. This is briefly the method followed by all observers, and hence is common to all systems of time signals. We have, then, as essentials of any such systems—(1) an instrument for observing the transits of stars; (2) a sidereal clock; and (3) a mean time clock. This mean time clock (like all timepieces) will not run accurately, its rate varying, being sometimes less and sometimes greater The pendulums of such clocks are generally very well compensated for changes of temperature, but it has been found that the density of the air has a decided influence upon the rate at which the clock runs; when the barometer is high, the clock loses on its rate, gaining when it is low. In order, then, that the time which is sent out over the wires should be correct, it is necessary either to have some arrangement for correcting the standard mean time clock so as to make it correct, or else to have a similar clock which can be likewise corrected; such a clock is known as a transmitter.

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The system of the Greenwich Observatory being the oldest in point of time merits the first description. The standard sidereal clock is a remarkably fine piece of workmanship, having, in addition to a peculiarly constructed compensated pendulum, an auxiliary apparatus intended to still further aid in the compensation for changes in temperature, which it would be impossible to describe intelligibly without a drawing. There is also an arrangement for counteracting the influence of the variations in the density of the air, which is the invention of Sir George Airy, and is very ingenious; two bar magnets are secured to the bob of the pendulum diametrically opposite each other, one with the north pole down, the other with same pole up; below these at a distance of about four inches is a horseshoe magnet which hangs on one end of a walking-beam, to the other end of which is attached a float resting on the surface of the mercury in the cistern of a specially constructed barometer; with a rise in the barometer the horseshoe magnet rises nearer the bob and thus exerts a stronger influence upon the swinging magnets, causing the pendulum to oscillate more rapidly: the contrary takes place when the mercury falls. Notwithstanding all these refinements the published records of the observatory show that the clock does not run with perfect accuracy, a variation of its daily rate as large as 1·15 seconds being recorded in a year. It does, however, run with but slight variations of rate from day to day; still it shows as great a loss as one minute in six months; it is supposed to be regulated to lose a small amount daily, but the records show that it occasionally gains as much as half a minute in five or six months. I mention this here in order to show you that those people who talk about their clocks or watches running to within a few seconds a year are probably somewhat wide of the truth. This standard sidereal clock registers its beats upon the chronograph used in observing transits, controls the remaining sidereal clocks in different rooms of the building, and finally drives (in unison with itself) a sidereal chronometer. The controlled clocks are upon the Jones' system (as modified by Sir George Airy); in this system the secondary clocks are required to be quite as good time-keepers as the primary one, which makes it too expensive for general use among the public. As used at Greenwich, the standard clock closes a circuit in which the controlled clocks are placed every second; on the pendulum of each of the latter is a magnet, which at the end of its swing enters a coil of insulated wire; as the current passes the effect is to hold the magnet within the coil, and hence to place the pendulum in a definite position, which corresponds in effect to that of the pendulum of the primary clock; this closes the circuit by means of a wheel on the seconds arbor, which presses upon a spring at each forward motion. The sidereal chronometer already spoken of in this connection is constructed practically upon the same principle as those of Wheatstone, referred to in the early part of these remarks.

This sidereal chronometer is in the time service room and is used for the purpose of comparison with a similarly-constructed mean time chronometer, which is driven by the mean time clock now to be described. This is essentially a galvanic clock of peculiar construction, and of which I imagine there are but few existing. As the pendulum swings to the right it closes a circuit through the coils of an electro-magnet which actuates a peculiar mechanism, by which, as the pendulum swings to the left, a weight is caused to impinge upon the pendulum, thus giving it the impulse which in an ordinary going clock it receives from the weight or spring; this impulse is given at each alternate vibration. At each extremity of the swing of the pendulum it closes a circuit which, acting upon the coils of two electro-magnets, alternately attracts and repels the opposite ends of a balanced polarised armature; this rocking motion is readily converted into a rotary one, causing the seconds hand to revolve, and, by the usual device of a train of wheels, the minute and hour hands also; there are several clocks driven by this pendulum, including the mean time chronometer just mentioned as being in the time service room. The apparatus for correcting the error of the standard mean time clock consists of a magnet secured to the pendulum which swings over a hollow coil of insulated wire attached to the clock case; if a current be passed through the coil in one direction the magnet on the pendulum is attracted and the oscillations are more rapid; if a current be sent in the opposite direction, the contrary is the case; a switch in the time service room serves to operate this arrangement when desired, and the battery is so arranged that it will accelerate or retard the pendulum at the rate of one-tenth of a second in a minute. The practical working of the observatory portion of the time service is as follows:—The error of the standard sidereal clock is obtained by means of star observations as before described; at 9 a.m. daily, the mean time and sidereal chronometers in the time service room are compared by what is known as the eye and ear method—that is to say, the observer waits for the coincidence of the beats of the two instruments and notes the time shown by each at this instant; applying the error of the sidereal clock to the time shown by the sidereal chronometer, the correct sidereal time is found; by a comparatively simple operation the corresponding mean time is found, and from this the error of the mean time, chronometer, or what is the same thing, the error of the standard mean time clock. Suppose that this clock is found to be one second slow, the switch to the coil in the clock is turned in the accelerating direction for ten minutes, during which time the pendulum is swinging faster than usual, and at the end of this period the clock has gained the necessary second; and not only the standard, but all the clocks that are driven by it. In this condition the standard is in readiness to be used as a transmitter; it is in circuit which is closed automatically every hour by the operation of wheels within the clock itself. The closing of this circuit operates a relay which transmits a single beat (that of 0 minutes and 0 seconds of the exact hour) to the General Post Office in London and also to the station of the railway leading to Deal. At this latter point a time ball is erected, and is dropped by the hourly signal sent at 1 p.m. The hourly signal is also transmitted over certain private wires belonging to various jewellers for the purpose of comparing their timepieces. In one case at least this signal is also used for the purposes of distribution.

The line to Deal is for a short time virtually under the control of the observatory, so that a return signal is sent which announces the fall of the ball. A very ingenious adaptation of the galvanic clock described as the mean time standard is in use on this circuit. At a certain point where the line to Deal is looped in, this second clock is placed. It is regulated so as to have a gaining rate of several seconds, so that at 1 p.m. it is always too fast. When that hour is shown by the clock, the circuit which operates the electro-magnet and thence the clock train is switched out automatically, and the Deal loop is switched in. The pendulum continues to swing until the passage of the signal from the observatory opens the circuit and the clock then moves on, showing the exact Greenwich time as it starts.

ELECTRIC LIGHT AT BATH.

At a meeting last week of the Council the Electric Light Committee presented a list of tenders received for lighting the following streets of the city:—Old Bridge, Dorchester-street, Southgate-street, Stall-street, Union-street, Burton-street, Old Bond-street, Edgar-buildings, York-buildings, Princes-buildings, Fountain-buildings, Oxford-row, Belmont, Alfred-street, Bennett-street, Saville-row, Circus, Brock-street, Royal-crescent, Gay-street, Queen-square, Charles-street, Seymour-street, Kingsmead-street, James-street, Kingsmead-square, Westgate-street, Sawclose, Upper Borough Walls, Wood-street, Green-street, New Bond-street, Broad-street, Northgate-street, Bridge-street, Argyle-street, Laura-place, Pulteney-street, Sydney-place, Edward-street, Darlington-street, Raby-place, High-street, Cheap-street, Orange-grove, Terrace Walk, North Parade, South Parade, and Manvers-street.

Seven tenders had been received, and Mr. STURGES now moved that that of Mr. H. G. Massingham be accepted. Mr. Massingham, he said, offered the system which had proved most successful—the Thomson-Houston—an illustration of which was given in High-street on the occasion of the Jubilee; his tender was the lowest; and Mr. Massingham was only acting as the mouthpiece of a number of well-known citizens, who might be depended upon to do everything they could to make the light a success. The expense of the light in the district named would be only £203 annually more than the cost of gas—or 20 per

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cent. more against the 50 per cent. more which was at one time anticipated. He dwelt on the importance of the city being to the fore in all improvements, and said that as the adoption of electric lighting out of doors would certainly lead to its introduction into shops and public buildings the health of the community would be improved and life lengthened. The contract proposed was for seven years, as no company could be found to put in an expensive installation with only a year guaranteed, but the contract would be so prepared that if the light did not prove successful it could be terminated at three or six months. The system of overhead wires was recommended; he knew that would be objected to, but it was the cheapest, and installation would be more perfect. He proposed that Mr. Massingham's tender be accepted.

Alderman MURCH, who seconded, said he had something like a feeling of regret at the prospect of parting with an old friend which had served them so faithfully for a great many years. But he was sure the Council would feel that gratitute for past good need not deter them from a prospect of future enjoyment. He trusted that Bath would continue to progress on the same lines on which she had advanced in late years, and that she would be prominent among the cities of the kingdom for the introduction of the electric light.

Alderman OLIVER said they were asked to make a great change—to do away with a light with which they were well acquainted, and to distribute an agent in lighting of which they knew little. Changes of this kind required great consideration and ample discussion, and this he did not think had been given to the subject. He was not at all interested in gas or electricity, and he did not say that the electric light would not be the light of the future; but he would say that it was now in its infancy. It had not developed as it should have done, and he contended that it would be wrong to saddle the ratepayers with additional expense, and to incur risk and uncertainty. Seven towns were mentioned in a previous report as having adopted the light. Well, in Brighton, the first named, it was not used; in Chesterfield it had been discontinued as too uncertain and expensive, and had been replaced by gas, and the town, as a penance for its electric fever, had turned the engine-shed into a Salvation Army hall, which, he had no doubt, would do more good; at Leamington it was admitted to be a failure, and the cost was double; at Eastbourne the cost of certain lamps was £560 compared with £240 for lighting the same area with gas, and the installation had proved most expensive and unsatisfactory in Greenock.

Dr. TUCKETT: Where did you say?

Alderman OLIVER: Greenock, in Scotland.

Dr. TUCKETT: I was there the other day and didn't see anything of it.

Alderman OLIVER, continuing, stated that the cost of the light in Taunton was said to be double that of gas. The report brought up some time ago was defective and unsatisfactory, and so was that presented now; it did not give the relative cost of gas and electricity, nor show the number of gas lamps which would be displaced. Seventy lamps were estimated to light fifty streets; which on an average was three lights to two streets. Would that be enough? He doubted it. Then there was the danger of overhead wires; and he understood if a man touched the wires during the time the installation was on he would instantly be a subject for a coroner. It was a question whether people living in the parts not to be lighted with electricity would agree to pay for the new light in other districts. The rate had increased greatly of late, and they should not be further burdened without the city receiving any advantage.

Alderman GIBBS also opposed the resolution. He contended that the electric light was as yet in its infancy, and would probably before long be rendered more perfect in these days when science made such rapid strides. Another objection was that the light would not be distributed fairly and equally. For instance, the important ward of Lyncombe and Widcombe would not have an electric lamp in it according to the present proposal. The limited area would not be permitted for long, and if it were extended they must consider the heavy expense that would accrue. Then was Bath a place in which this improved light was wanted? It was a quiet town, and had not the same traffic in the dark which was to be found in places where electricity had not been adopted. Mr. Sturges, when wending his way home to his London lodgings from the Opera House (laughter) would find men turning down the gas lamps, and that was in the city of London, a place where it was essentially necessary to have as much light as possible. There was no immediate need for the electric light, and by adopting it they would increase the present taxation, which in many cases was found exceedingly heavy by the poorer classes, who, for the most part, would be in bed when the electric light was shining out of doors. They must also consider the evil and uncertainty of disarranging the present system.

At 1.30, on the suggestion of the Mayor, the discussion and the other business on the agenda paper were adjourned.

The following communication, which was enclosed with Mr. Massingham's tender, the contents of which we referred to in a note last week, was sent for publication:—

Bath, June 30, 1888.

Dear Sir,—I send the enclosed tender at the request of those citizens of Bath who are desirous of seeing our beautiful city progress with the times. The tender is based upon an estimate to pay only 5 per cent. per annum upon the capital employed, provided everything is conducted upon the most economical scale. I believe it is the lowest tender that has ever been made for public electric lighting, and, if accepted, those citizens who are acting with me will at once form a local company for supplying the light permanently for private as well as public use, so that the bathing establishments and other places can at any time be lighted. I recommend 69 lamps, but if the North and South-parades are included, which are not shown on the official plan, two more lamps will be wanted, making a total of 71. These 71 arc lamps being placed principally at the junction of streets, displace 315 gas lamps, which I have reckoned at £3 8s. each, making £955 10s. They also displace 18 large lamps, 12 of which I have considered as costing £10 3s. 1d. each, and 6 £8 8s. 7d. each, making £171 16s. 6d., a total of £1,127 6s. 6d.

The total cost of the 71 arc lamps, reckoning them at £18 17s. 6d. each, is £1,330 2s. 6d. This is a lower price than I have ever led the Council to expect. The sum I named when first asked being 50 per cent. more than gas, whereas this estimate is only 20 per cent. more, though giving several hundred per cent. more light.

If this tender is accepted I would suggest, instead of terminating the district at the Circus, the Council extend it through Brock-street to the end of the Royal-crescent, and instead of leaving off at the bottom of Pulteney-street, extend it to the end of Sydney-place on each side of that street, returning through Darlington-street, Vane-street, and Edward-street, taking in Raby-place. This would require ten additional arc lamps, costing but a trifle more than the present gas.

H. G. MASSINGHAM,
Originator of the Taunton Installation, and Managing Director of the Taunton and Exeter Electric Lighting Companies.

The Bath Town Council, on Tuesday last, by 22 votes to 12, decided to light 50 principal streets with electric light. Several shareholders of the Gas Company in the Council did not vote. Mr. Massingham's tender was accepted.

LEGAL INTELLIGENCE.

THE SIMPLEX ELECTRIC LIGHT AND PLANT COMPANY, LIMITED, v. COOPER AND CRAIG.

Mr. Bigham, Q.C., and Mr. Hopkinson were counsel for the plaintiff company, and the defendants were represented by Mr. Gully, Q.C., M.P., Mr. Yates, and Mr. Brierley.

Mr. Bigham said the action was brought to recover the price of installing the electric light at the colliery of the defendants, in Staffordshire, and also to recover several items for goods supplied and work done.

The defence, briefly stated, was that the plaintiffs did not do their work to the satisfaction of the defendants. After opening the case, Mr. Bigham suggested that the better course would be to refer the matters in dispute to a practical electrical engineer.

The **Judge** said he did not like to shrink from any duty that was cast upon him; but, in any event, a considerable portion of the case must be referred, because to some extent the case was one of accounts, and under all the circumstances he thought the parties would be more likely to arrive at a satisfactory settlement by referring the disputed points.

After counsel and clients had consulted together—

Mr. Gully announced that it had been decided to refer the case to a gentleman to be agreed upon between the parties. If the parties could not agree upon the referee, application would be made to his Lordship to nominate a gentleman.

COMPANIES' MEETINGS.

INDIARUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY.

The half-yearly general meeting of the Indiarubber, Gutta-Percha, and Telegraph Works Company, Limited, was held on the 19th inst. at the City Terminus Hotel.

Mr. S. W. Silver presided, and, in moving the payment of an interim dividend of 5 per cent., observed that the working of the Company so far this year had been of a satisfactory character.

Mr. Neil Bannatyne seconded the motion.

In answer to questions, the **Chairman** stated that the telegraph works were only partially employed. They lost no opportunity of seeking employment for their ships, and one of them had been engaged in the service of the Italian Government. Their books were made up only once a year, but the impression of the Directors was that the dividend now proposed had been earned out of the half-year's profits.

Mr. Gray (the managing director), in further reply to **Mr. Webber**, said he was perfectly certain that their coal was bought well, and in the market where they got them cheapest in price and best in quality.

The resolution was carried.

MAXIM-WESTON ELECTRIC COMPANY.

An extraordinary general meeting of the Maxim-Weston Electric Company, Limited, was held on the 19th inst., at the City Terminus Hotel, having been summoned by a requisition from shareholders to appoint additional Directors. Mr. Hugh Watt, M.P., presided.

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On the motion of **Mr. Hirsch**, it was resolved to add five Directors to the Board, and, subsequently, after some discussion, it was agreed, on the motion of **Mr. Hildyard**, seconded by **Mr. White**, to appoint the following gentlemen members of the Board:—Messrs. J. M. Klenck, John Marks, G. H. Hildyard, W. D. Harvist, and J. G. Couchman.

The Chairman afterwards made a statement reviewing the history of the Company, expressing his readiness at all times to act with any additional members on the Board, and giving a hopeful view of the Company's prospects.

A vote of thanks having been passed to the committee of investigation, the proceedings became informal, and Mr. Watt having vacated the chair, Mr. Louis Swaby, one of the old directors, was invited to preside.

A long and animated discussion then followed on a suggestion by Mr. John Newton that the committee should receive a certain sum in consideration for their services in investigating the affairs of the Company. Ultimately it was agreed, with a few dissentients, to recommend the Directors to reimburse the committee for their outlay in the interests of the shareholders a sum not exceeding 100 guineas.

Another angry discussion ensued on a suggestion as to whether Mr. Watt should be asked to retire from the Board, but no decision on the subject was arrived at, and the meeting ended in disorder.

EASTERN TELEGRAPH COMPANY.

The thirty-second ordinary general meeting of the Eastern Telegraph Company, Limited, was held on the 19th inst. at Winchester House, Old Broad-street, under the presidency of Sir John Pender.

The **Chairman** stated that the revenue for the past half-year to March 31 last had been £359,706, or £27,844 in excess of the revenue for the corresponding period of the previous year. From their investment in the Eastern and South African Company, nearly all the shares in which belonged to the Company, they had received £31,200, or £7,800 more than in the previous year. Their return from the Black Sea Telegraph Company, owing to an interruption in the cable, had been £1,300 less; and on their ordinary shares in the Direct Spanish Telegraph Company, in which they had a controlling influence, they had received £676, against *nil* in the corresponding period of the previous year. The Company had now "turned the corner." The total working expenses of the Company in the past half-year had been £87,134, or £4,099 more; and the expenses attending the repairs and renewals of cables had amounted to £38,412, or £5,491 less, although they had charged under that head the whole cost of duplicating the Zantre-Patras section of about 60 miles. After charging all expenses, including income-tax, interest on debentures, debenture stock, and preference shares, they were able to pay a dividend of 5 per cent. and a bonus of 1 per cent. for the past year, and to transfer to the general reserve fund £75,000, leaving £884 to carry forward. They had charged the whole cost of triplicating the Porthcurnow-Malta cable and the extension to Zante to the reserve fund, which was thus left at £342,338. With the special reserves stated in the balance-sheet, their total reserves amounted to £362,606. They had also charged the amount expended on the new screw steamer, "Amber," to the maintenance ships' fund. The issue of the four per cent. mortgage debenture stock, to pay off the Five per Cent. debentures, was now complete, and the premium of £2,366 on its issue had been credited to the reserve fund. The total capital amounted to £5,900,000, and the expenditure to £5,965,000. They proposed to make arrangements to dispose of the £62,000 of six per cent. debentures of the Direct Spanish Company, and when that was complete the capital and the capital expenditure would practically balance. They would then be able to increase the investments on account of their reserve funds. They had recouped the loss incurred through the reduction of rates forced on them at the Berlin Telegraph Conference. He concluded by moving the adoption of the report and the payment of the dividends and bonus recommended.

The **Marquis of Tweeddale** seconded the motion.

In reply to **Capt. Goodsall**—

The **Chairman** stated that the length of cable between Porthcurnow and Zante was 2,728 miles. The cost of the "Amber" was £29,000 odd.

The motion was carried unanimously.

DIRECT UNITED STATES CABLE COMPANY.

The twenty-second ordinary general meeting of the Direct United States Cable Company, Limited, was held at Winchester House, Old Broad-street, on Friday last.

Sir John Pender, who presided, stated that the revenue for the half-year, after deducting out payments, and including income-tax refunded, had been £17,508, and the working and other expenses, including income-tax, but exclusive of the cost of repairs, had been £15,277, leaving a balance of £2,231 as the net profit of the half-year, making, with £9,911 (composed of £6,899 interest and profit and £3,012 of principal) transferred from the reserve fund account, a total of £12,142, with which two interim dividends of 2s. each had been paid. A final payment of 2s. a share for the quarter ended the 30th ult. was now proposed, making, with the three interim dividends already paid, a total of 2 per cent. for the financial year. The revenue, owing to the low rates current, showed a reduction of £6,064 as compared with that of the corresponding period of last year; and the expenses and other payments exhibited a reduction of £628. The cost of the current repairs amounted to £25,222 to the 30th ult. That sum was at present standing in the balance-sheet, but it would be dealt with later on, together with the cost of completing the repairs. The investments continued worth much more than they had cost the Company. When he last addressed them he went fully into the details of the negotiations then going on in regard to raising the rate. The 6d. tariff had been given a thoroughly fair trial in the last two years, and he had never believed it would give them a fair dividend. The negotiations had been going on more or less ever since the last meeting, and they had culminated now in the Anglo-American, the Western Union, the Commercial, and the Direct Companies seeing the folly of continuing the tariff of 6d. a word any longer. Representatives of the French Company would be seen by them on Monday, and he saw no reason for supposing they would not agree with the other companies interested. He thought they might assume that they would agree, and in that case the rate would be raised to 1s. a word on the 15th prox. If they obtained at the 1s. rate all the traffic they now had at 6d. a word, they would be very much in the position they were in when the tariff was 2s. a word, and when they were enabled to pay a respectable dividend. The 1s. tariff would be given a year's trial, and if the public did not support them at that rate to the extent they now did, it would be for their consideration a year hence whether any further change should be made in the tariff. It would be distinctly understood that there were to be no rebates. He had hoped to be able to inform them that their cable was in thorough working order again; but they had lifted the cable from 2,200 fathoms of water and taken out one important fault. He concluded by moving the adoption of the report, and a final dividend of 2s. a share.

Mr. William Ford seconded the motion.

In reply to questions, the **Chairman** stated that the old pool would continue. The Commercial Company had simply agreed with them as to raising the rate, in connection with which the pooling arrangement was not involved. The cost of the repairs to the cable would be charged to the reserve fund. When they could better afford it, he would be very glad to agree to the appointment of a managing director. Meantime they were effecting a considerable saving, and their interests were completely safeguarded. He had himself been acting practically as the manager of the Company. It was unfair and altogether wrong to treat the dividend now paid as if it were the regular distribution. The cable was last year removed to a position of far greater safety at Halifax.—The motion was then adopted.

A discussion followed on the question of the re-election of the retiring Directors, it being argued by some speakers that five Directors were sufficient, and that the fees of the Board ought to be less.

The **Chairman** stated that before the present Board took office and rescued the Company from ruin the shareholders had never received a dividend, while for some years the Directors had paid them a dividend of 5 per cent., and had also formed a large reserve fund.

Ultimately the retiring Directors were re-elected, as were also the Auditors.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ending July 20 amounted to £4,633.

Western and Brazilian Telegraph Company.— The traffic receipts of the Western and Brazilian Telegraph Company, Limited, for the week ended July 20, after deducting the "fifth" of the gross receipts payable to the London-Platino Brazilian Telegraph Company, Limited, were £3,924.

Submarine Telegraph Company.—The accounts of the Submarine Telegraph Company for the half-year ended June 30, 1888, submitted to the Board, show a balance, subject to audit, which enables the Directors, after adding 15 per cent. of the gross receipts to the reserve fund, to recommend a dividend at the rate of 13½ per cent. per annum.

Cuba Submarine Telegraph Company.—At a meeting of the Directors of the Cuba Submarine Telegraph Company, Limited, held on Wednesday last, the audited accounts for the half year to the 30th June were submitted, and it was resolved, after providing for the dividend on the preference shares, and placing £6,000 to the reserve fund, to recommend the payment of a dividend on the ordinary shares at the rate of 9 per cent. per annum, tax free, leaving £1,195 to be carried forward to the current half-year's account.

Globe Telegraph and Trust Company.—The report of the Directors of the Globe Telegraph and Trust Company, Limited, for the year ending 18th of July, 1888, shows that the net revenue of the Company, after deduction of expenses, amounted to £168,053, which, with the balance of £1,442 brought forward, makes a total of £169,496. From this amount there has been distributed the sum of £114,023 in interim dividends, leaving an available balance of £55,472. The Directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares and 3s. per share on the ordinary shares, making, with the former distributions, a total dividend for the year of 6 per cent., less income-tax, upon the preference and 3½ per cent. net upon the ordinary shares (against 2⅞ per cent. for the preceding year), and carrying forward a balance of £2,107.

NEW COMPANIES REGISTERED.

City of Westminster Electrical Syndicate, Limited.—This Company intends to erect a central or other station, &c., for the creating, producing, generating, accumulating, distributing, storing, and supplying electricity, electrical motive force, or any similar agency for lighting, heating, motive signalling, telegraphic, telephone, and other purposes, in the city and liberty of Westminster and elsewhere, and to lay down, establish, fix, and carry out all necessary wires, lines, communications, accumulators, lamps, and works for such purposes, or any of them. The capital of the Company is £10,000, divided into 10,000 shares of £1 each.

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PROVISIONAL PATENTS, 1888.

JULY 13.

10,194. **Improvements in electrical switches.** Arthur Cecil Cockburn, 2, Aubert-park, Highbury, London, N.

10,209. **An improved electric regulator.** Frédéric Victor Maquaire, 53, Chancery-lane, London, W.C.

10,220. **Means or apparatus for automatically establishing electrical contact for motion and light purposes on receipt of a coin in views or other boxes, said coin being freed at a fixed period following the motion.** William Speirs Simpson, 166, Fleet-street, London.

JULY 14.

10,245. **Improvements in and connected with electrical safety cut-outs.** Ernest Perrett, 77, Chancery-lane, London, W.C.

JULY 16.

10,299. **Improvements in electric logs.** Nesbit Willoughby Wallace, 53, Chancery-lane, London, W.C. (Percy Scott, H.M.S. "Edinburgh," Malta.)

JULY 17.

10,363. **Improvements in and relating to multiple telegraphy.** Ernest Jules Pierre Mercadier, 169, Fleet-street, London.

JULY 18.

10,415. **Improvements in the production of hydrated proxide of iron from galvanic dry elements.** C. Gassner, jun., 33, Southampton-buildings, Holborn, London. (Complete specification.)

10,434. **Electric material for medical and curative purposes.** Thomas Field, jun., 11, Queen Victoria-street, London, E.C.

10,437. **Improvements in printing telegraphs.** John Edward Wright and John Moore, 24, Southampton-buildings, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

JULY 19, 1887.

10,116. **Improvements relating to apparatus for the automatic delivery of goods, the display of advertisements, the imparting of electric shocks, and similar purposes.** John Stewart Wallace, 45, Southampton-buildings, London, W.C.

10,131. **Improvements in meters or apparatus for measuring electricity.** George Forbes, 24, Southampton-buildings, London, W.C.

JULY 20, 1887.

10,157. **Improvements in and connected with apparatus for transmitting and receiving electrical signals.** Thomas Alexander Garrett, 80, Abingdon-road, Kensington, London, W.

AUGUST 17, 1887.

11,252. **Improvements in secondary batteries or electrical accumulators.** Henry Mower, 47, Lincoln's-inn-fields, London.

SEPTEMBER 2, 1887.

11,901. **Improvements in lamp-holders or sockets for incandescence electric lamps.** Ronald Augustus Scott, 331, King-street, Hammersmith, Middlesex.

SEPTEMBER 5, 1887.

12,015. **Improvements in incandescent electric lamps.** Wilhelm Lönholdt, 45, Southampton-buildings, London.

SEPTEMBER 19, 1887.

12,683. **Improvements in the manufacture of spongy lead suitable for electrical accumulators.** François Marie Arthur Laurent-Cely, 169, Fleet-street, London.

SEPTEMBER 20, 1887.

12,718. **Improvements in electrical speed indicators.** James Tate, Sunbridge Chambers, Bradford, Yorkshire.

MARCH 13, 1888.

3883. **Improvements in electrical devices for type-writers** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.)

MARCH 19, 1888.

4221. **Improvements in the construction of holders for incandescent electric lamps.** Theophilus Coad, 10, Thorpe-terrace, Thorpe-road, Forest Gate.

MAY 29, 1888.

7852. **Improvements in or relating to central station apparatus for system of electric distribution by alternate currents.** William Phillips Thompson, 6, Lord-street, Liverpool. (George Westinghouse, jun., United States.)

SPECIFICATIONS PUBLISHED.

7185. **Electro-propulsive motors, &c.** W. H. Akester. 8d.

10,177. **Electric batteries.** E. L. Mayer and H. Liepmann. 6d.

11,390. **Secondary batteries.** J. S. Stevenson. 8d.

11,417. **Electrical connection with moving bodies.** T. A. Garrett. 8d.

11,502. **Dynamo-electric and electro-dynamic machines.** E. F. H. H. Lauckert. 6d.

11,816. **Medical magnetic appliances.** R. Lonsdale. 8d.

13,758. **Electrical apparatus for dental operation.** A. J. Boult. (Smith and Kimble.) 8d.

1888.

7536. **Galvanic batteries.** B. Willcox. (Whittier.) 4d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday.
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	2¾
12 Feb.	2/0	— fully paid	5	3¾
26 April	1%	Anglo-American	100	41⅛
26 April	2%	— Pref.	100	69
12 Feb., 85	5/0	— Def.	100	14
28 June	3/0	Brazilian Submarine	10	12¾
14 June	1/0	Con Telephone & Main	1	¾x
15 Feb.	8/0	Cuba	10	13¾
28 July	10/0	— 10% Pref.	10	19½
28 Mar.	2/2½	Direct Spanish	9	4
28 Mar.	5/0	— 10% Pref.	10	10
28 Mar.	2/0	Direct United States	20	9⅛
12 April	2/6	Eastern	10	12¼
12 April	3/0	— 6% Pref.	10	15¼
1 Feb.	5%	— 5%, 1899	100	111
26 April	4%	— 4% Deb. Stock	100	106½
12 July	2/6	Eastern Extension, Australasia & China	10	13
1 Feb.	6%	— 6% Deb., 1891	100	107
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	103
28 Mar.	8/3	German Union	10	9⅛
12 April	2/0	Globe Telegraph Trust	10	6¾
12 April	3/0	— 6% Pref.	10	14¼
30 April	5/0	Great Northern	10	14¼

Dividend.		Name.	Paid.	Price. Wednesday
1 Mar.	5%	Gt. Northern 5% Deb., '83.	100	108
29 Feb.	10/0	India Rubber, G. P. & Tel.	10	17½
11 May	37/6	Indo-European	25	38
30 May	3/0	London Platino-Brazilian	10	6¼
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	⅝
26 April	4/0	Reuter's	8	8
		Swan United	3½	2⅝
15 Feb.	15¼%	Submarine	100	150
15 Oct.	6%	Submarine Cable Trust	100	97
29 Feb.	36/0	Telegraph Construction	12	39½
3 Jan.	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13
		West African	10	5¼
1 Mar.	5%	— 5% Debs.	100	95
12 July	4/0	West Coast of America	10	6¼
30 June	8%	— 8% Debs.	100	117
11 May	9/	Western and Brazilian	15	10⅛
11 May	6/10½	— Preferred	7½	6⅛
11 May	2/1½	— Deferred	7½	4⅛
1 Feb.	6%	— 6% A	100	113
1 Feb.	6%	— 6% B	100	108
		West India and Panama	10	1
30 May	10/0	— 6% 1st Pref.	10	11
13 May, '80		— 6% 2nd Pref.	10	7¾
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	104

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NOTES.

The Stockport Gas-Engine.—The Stockport gas-engine is coming much into favour.

Extinguished by a Rocket.—Forty arc lights were extinguished at St. Louis on the night of the fourth of July jubilation by a sky-rocket, which broke the wire in its flight upwards.

Motors for Sewing Machines.—A large costume establishment in Buffalo, N.Y., has a 5 h.p. Sprague motor fitted up to drive all the sewing-machines used in the establishment.

Tender Wanted.—The Cowpen District Local Board (Blyth, Northumberland) are inviting tenders for lighting their district by electric light. The Surveyor to the Board will supply particulars.

North Metropolitan Tramway Company.—At the recent meeting it was stated that, by the next half-yearly meeting, it was expected that many of the cars would be run by electricity.

The Richmond Electric Road.—The passenger traffic on the Richmond, Virginia, electric tramway was very successful on the fourth of July holiday. As many as 17,108 passengers were carried.

Telephone in Vienna.—The charge for telephone in Vienna has been reduced to £8 a year. Many new subscribers have joined at this rate. The total is now 1,200, and new telephone wires are being laid underground.

Richmond.—We see from the local papers that Mr. J. N. Shoolbred has written to the Richmond Vestry, to ask them to assure the West Middlesex Electric Lighting Company that they have already power to electric light Richmond themselves.

Tender Required for Exeter.—Under date July 18, the Town Council of Exeter advertise for tenders for lighting with arc light for a period of seven years. A deposit of two guineas, to guarantee a *bonâ fide* tender, is required for copy of conditions, which can be obtained at the town clerk's offices, 15, Bedford-circus, Exeter.

Arc Lights on Excursion Steamers.—The use of electric light on board ship is extending to the excursion steamers in America. The Van Depoele Company of Chicago has recently supplied a plant for this purpose, consisting of 15 arcs and 40 incandescent lamps.

What they found necessary.—The *Electrical World* notices the filing of a paper in the American courts from the Electric Storage Battery Company, certifying that the 10,000,000dols. capital is paid—"2,500dols in cash, and 9,997,500dols. in the purchase of patent rights necessary to carry on the business"!

Extending the Life.—In the use of incandescent lamps for train signals on the South Pacific Railway, which are highly successful, the electrician uses only half the lighting capacity of the lamps to replace the oil-lamps, and finds the life of the lamps extends to more than ten-fold by this usage, and the total cost is only one-third that of oil.

Wire Gauze Brushes.—By a slip of the printer, in our note of Mr. Crompton's wire gauze brushes last week, the word "gauze" was written "gauge." Those who did detect the error might read the note again. We believe these dynamo brushes, made out of wire gauze cut on the bias, will have an important place among the minor details of electric lighting.

New Electric Conductors.—A compound electric conductor has been patented in Vienna by Karcis and Bondy, consisting of two metals, a copper core and iron or steel wound spirally over this in the form of wire or thin ribbon. It is supposed to have superior advantages, being of great tenacity, low resistance, and without self-induction.

Electric Light on the Suez Canal.—Considerable trade is done on the Suez Canal by bringing out electric light plants for night use. Many of the ships have their own projectors, but those that are not so fitted are glad to use the projectors on hire, for the use of which they pay the sum of ten pounds. The apparatus is then used for a backward journey.

Oil on the Waters.—A new invention for oiling troubled waters consists in a rocket which can be fired before the ship even in a gale and discharges oil to smooth the water ahead. If electric launches ever, as they may soon, traverse open sea, they will have to be equipped with an electric squirt or rocket gun to smooth their onward way, and the troubles of sea-goers will be doubly overcome.

English Plant for America.—We learn that Messrs. Hammond and Co. are completing a large plant, on the Lowrie-Hall system, for a central electric lighting station in America. The Americans seem to think, by advices we hear of companies continually introducing their systems here, that we want teaching how to do central station lighting, and that they are just the people to do it. This item looks as if sometimes it was the other way round.

The Waterhouse System.—We learn that Messrs. Shippey Brothers, Limited, have been appointed agents to exploit this arc-light system for England, an illustration of which was given in our journal of June 1, 1888 (page 514). This company makes a speciality of 30, 50, 100, and 200 h.p. arc-light plants for provincial town lighting; and they guarantee to give ninety 1,700-c.p. lamps (nominally called 2,000 c.p.) for an actual expenditure of 50 horse-power.

Testing for Poor Connections.—It is sometimes necessary to determine the existence of a poor connection and to fix its position. Mr. A. Barrett, electrician-in-charge of the Kansas City installation, measures the circuit for resistance with a single cell, to test for this fault, and then with six or eight cells. If a poor connection exists the two measurements will vary considerably; if not there is no perceptible difference. This method has been found reliable and useful.

Corporation Lighting for Paris.—The Paris Corporation held on Friday night the closing sitting of its extraordinary session. It rejected two applications for a concession to light Paris by electricity, the contractors not having followed the specifications laid down by the Municipal Council, and voted a grant of £40,000 for the erection within the Halles Centrales of electric works for the supply by mains of the whole city. It is doubtful, however, whether the Government will allow the Corporation the exercise of such a monopoly.

The Magnetic Crane.—We recently described the application of very strong magnets for the purpose of lifting heavy pieces of pig iron. One peculiar point learned in connection with this magnetic substitute for the ordinary hooks used on cranes was that the magnet would attract the chain above equally well with the mass below, and lifting chains used on the crane were consequently entangled in the most puzzling snarl until ropes were substituted. It is quite possible that this apparatus affords an excellent

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field for the brass chain made by the electric welding process of Professor Elihu Thomson.

Electric Light in Parks.—The application of arc lighting for the illumination of pleasure parks at night has been mooted for London. Baltimore, U.S., has tried the scheme and likes it. The electric lights which have been placed in Druid Hill Park were turned on last week for the first time, and the effect was fine. The lights extend from Madison-avenue entrance to the Mansion House, and placed at intervals of about 100 yards. The lights when turned on drew crowds of visitors to the park, who promenaded about enjoying the novelty of the occasion and also the beauty of the surroundings.

Hose Pipes in Electric Towers.—The city of St. Louis and other cities are investigating the merits of the tower system for electric wires, both for electric light wires and for the telephone and telegraph, now being developed at New Orleans, this system being preferred, among other reasons, because of the dampness of the soil. The second tower at New Orleans is now in course of erection. It is of attractive style, very light, and less obstructive to the view than ordinary electric towers, and is 150ft. in height. The authorities of New Orleans, in granting permission to construct the tower, stipulated that an iron pipe should be run up each tower, to be used in extinguishing fires, especially on the uneven and higher buildings, which cannot be reached by the fire-engines.

Testing Telephone Circuits.—Mr. Henry L. Bailey, electrician of the Bell Telephone Company of Missouri, says a peculiar feature of the exchange is that the entire system is tested every morning without "calling" a subscriber. The night chief makes the test of about 2,200 circuits in less than an hour, determining the condition of each circuit. A list of faults is laid on the day chief's desk, and he directs the inspectors, who report from telephone stations convenient to their residences, so that they remove the faults before they report at the office in the morning. As a rule the lines are cleared by 9 o'clock every morning. Mr. Bailey considers this exchange in many respects far in advance of anything he has ever seen.

A Comprehensive Central Station.—In Lynn, Massachusetts, is a central station which comprises a considerable variety of supply. The station has at present a capacity of 800 h.p., and was originally started for supplying electric light for the town along the shores at Beachmont. The new electric railway of the Boston and Lynn Company, to Crescent Beach, is now supplied by current from the station to the extent of 40 h.p., which will be increased by another 80 h.p. Thomson-Houston arc lights are being supplied from this station to the number of 125, shortly to be increased to 200. It is also running a 500 light incandescent alternate current dynamo, which in a short time will be doubled. This station, when complete, will be one of the largest and best equipped in New England.

New Brooms.—In the recent discussion on the electric light at the Bath Town Council a small joke was perpetrated between them by Mr. Cox and Alderman Gibbs. Mr. Cox, in opposing the subsidising of the company by the Corporation, mentioned the Thomson-Houston system, and alluded to it as a comparatively new system; he was told it was the perfection of electric lighting, but he must say it was a new broom, and probably swept clean at the commencement. Mr. Sturges denied it was an attempt at subsidy. Some persons, he said, no doubt objected to the proposal, and button-holed Mr. Cox about it, but that did not prove his unpopularity. As for the electric light being a new broom that swept clean, he never heard such nonsense. What connection was there between the electric light and a broom? Alderman Gibbs: There is the "Brush" system.

Paris Convocation.—At the Paris Exhibition of 1889 an international convocation of electricians will be called by the Société Internationale des Electriciens, to continue the work of the convocation at Paris of 1881. *L'Electricien* suggests the following questions to be settled: (1) To define and fix the practical units of power and energy derived from the C.G.S. system, *watt* and *joule*, in order to prevent the confusion which are continually encountered in recent works, even by the most esteemed authors; (2) To define and fix a *practical* photometric unit, the standard advocated by M. Violle not having been recognised by industrial circles; (3) To define and fix photometric measurements and the corresponding units, in order that the *uminous intensity* of a luminous point may not be confounded with the *quantity of light* and the *degree of lighting* produced by this point at a given position.

An Electric Bone Cutter.—Removal of sections of bone in surgical operations has heretofore been a long, tedious process, effected with a mallet, chisel, gouges, &c. It is, perhaps, the most brutal and unscientific method which could be adopted, and sounds like the operative butchery which existed in the last century. This has all been reformed by an invention called the electric osteotome, which is an instrument holding a circular saw at its extremity, revolved with lightning speed by an electric motor. This, when held against a bone, makes a clean cut through it in a few seconds; in fact, its action is instantaneous. By holding the osteotome in a slanting position, wedge-shaped pieces can be cut out with equal promptitude. There is no danger of the saw cutting the soft parts, as they are protected by a retractor, an instrument which is passed down and under the bone.

Ilfracombe Promenade to be Lighted.—At the special meeting of the Ilfracombe Local Board on Saturday, letters were read with reference to lighting the Victoria Parade. Messrs. Woodley, of London, offered to light the promenade with electricity, on an average of five hours a night, for £150 for the first year, provided the Board would pay £60 in the event of the fittings being taken away, and also offered to light the whole town with 272 lamps of 50 candle-power for £680 a year. The gas company offered to lay plant for lighting it with gas for about £180; the gas used would be about £50. Tenders were also received from Messrs. Sugg and Company and Mr. William Cole. It was resolved, after discussion, to accept Messrs. Woodley's terms for one year, the surveyor being asked to explain to them that the lamps would not be wanted for several months in the year. The surveyor was also instructed to ascertain the cost of similarly lighting the parade.

Hiring Out Motors.—A local paper at Newark, New Jersey, says: "The Daft Electric Company, which is the new applicant for favour in this city, will start a striking innovation, inasmuch as the motors instead of being sold outright will be rented to the consumers of power at a fixed sum per month, which will include the service of energy required and all necessary repairs which otherwise fall upon the purchasers of the motors and are considerable in the course of a year. The Daft Company is coming to

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Newark, and will take offices at the headquarters of the Schuyler Electric Light Company. By this arrangement it will be possible to furnish power throughout a large circuit in the city for running fans, printing presses, elevators, sewing-machines and machinery of all kinds requiring from one-half to fifteen horse-power. If needed, electric lights can be put in to accompany the motors, and the lessee of the power can illuminate his place from the same source with slight additional cost."

Barnet.—The incandescent lamps for this station are to be 30 c.p. low-tension lamps run in series, with an automatic series fuse, and a switch for use if necessary. The lamps will be placed on ornamental lamp-posts, specially designed, 15ft. high, with reflector to throw the light down, and carrying an insulating shackle on the topmost point. Cable of 6,000 megohm resistance will be used for a certain distance each side of the shackle, and from these bare wire will connect to the next lamp. It is intended to use an independent steam-engine and dynamo to drive the street lighting, so as to be quite distinct from the private and shop lighting. The use of 30 c.p. lamps has proved itself successful in towns in America, distributed at the proper distances, and has in some cases replaced the tower system, by which a very strong arc light was erected at a great height to illuminate a whole district. The greater number of smaller lights insures a much more thorough illumination than could be obtained by the tower plan.

Electric Cars the Biggest Thing Out.—Mr. L. L. Lewis, of the Sacramento Electric Railway, is a great believer in electric cars. "Sacramento is going to have an electric railway," he says, "and it will be something of which the capital city will be proud. I have ordered cars from the Electric Car Company of America, whose immense works are at Philadelphia. I have a contract by which the first car, fully equipped, must be delived in Sacramento by July 1. It will be a sixteen-foot four-wheel car, with a storage battery of 8 h.p. The brakes, gongs, headlights—everything—are run by electricity. On Washington-avenue, in St. Louis; Fifth-avenue, New York, and in Philadelphia, I rode on electric railways, and they are the biggest thing out. The cars glide along without jolt or jar, and are under perfect control. The works in Philadelphia are unable to supply the demand for electric cars, and an addition for the exclusive manufacture of these cars is being made at a cost of over thirty thousand dollars."

Electrolytic Test Papers.—We have received from A. Wilke, electrician, of Berlin, a small booklet of test papers for ascertaining the poles of a cell, dynamo, or accumulator. These consist of a number of leaves of porous white material cut into five strips in each page which can readily be torn out, and then, moistened with the tongue or with water, they can be applied to the poles of the apparatus to be tested. On the current passing, the negative end turns red. The papers are put up in a very convenient form for use in the testing-room or laboratory, but we suppose it is hardly meant to be considered as a new invention. Faraday mentions an experiment of this nature in his works, and it has been a common usage among experimental electricians to take strips of ordinary white blotting paper moistened with a strong solution of iodide of potassium, which turns red at the negative pole. Messrs. Woodhouse and Rawson also utilise this action in their pole-tester, in which two knobs are immersed in such a solution, the negative knob taking a reddish tinge, which afterwards disappears. The little books of test papers of Herr Wilke will doubtless prove advantageous for purposes of this kind, and are put up in a very convenient manner.

Telegraphic Communication with Lighthouses. On Monday Sir G. Baden-Powell asked the First Lord of the Treasury whether, with a view to the better prevention of loss of life and property in cases of shipwreck, for the general advantage of the shipping and fishing industries, and for the more effectual defence of these realms in time of war, Her Majesty's Government would during the recess take into consideration the provision of a complete system of telegraphic communication between the postal telegraphs and all coastguard, lighthouse, lifeboat, and life-saving stations situated on the coast of the United Kingdom. Mr. W. H. Smith said, in answer, that with reference to the better prevention of loss of life and property at sea, I can only remind my hon. friend of the answer he received on April 16 last from my right hon. friend the President of the Board of Trade. In that answer it was stated that certain experiments must be continued for another 18 months, and, as that period has still many months to run, I am unable to give any further information on the subject. So far as regards the safety of this country, my hon. friend may rest assured that any measures which in the judgment of the Government are necessary for security will not be neglected by Her Majesty's Government.

Poole still keeps Gas.—At a meeting of the Poole Town Council, the Lighting Committee reported that, in consequence of the tenders having been referred back on account of some being irregular, considerable reductions had been obtained. The Poole Electric Light Company were only prepared to light the town proper with electricity, and, therefore, the committee could not recommend the adoption of that system at present. They had ascertained that the cost of lighting the town with electricity, and the outlying districts with oil, on a seven years' contract, would be £514. 7s. 6d. annually. The cost of lighting the borough with oil, on a three years' contract, would be as follows: With "Eclipse" burners, £470. 16s. 3d. annually; with "Empire" burners, £502. 4s. The cost of lighting with gas where available, and with oil where gas was not laid on, including £25 for supervision, on a three years' contract, would be £517. 10s. 2d. The committee, therefore, recommended the Council to accept the gas company's revised tender for gas at 3s. 6d. per 1,000 for three years. On the adjourned application of the Electric Light Company for permission to erect iron standards in different parts of the town for private lighting again coming before the Council, it was agreed to ask the company to submit drawings of the proposed posts.

Electric Tramcars Run by Gravity.—The following account from Columbus, Ohio, illustrates the possibility of working tramcars going up hill by the current generated by cars running down hill. Says a local paper: "An interesting sight was witnessed on the electric road last evening. As is well known, the track has a very steep grade between High-street and its eastern terminus. Last evening, as one of the cars was leaving the High-street end of the line, Prof. Short asked the engineer to stop the engine, which was done, thus shutting off the source of power. Still the car near High-street moved on up the grade without any apparent cause—without any power being delivered to it from the engine and dynamo, which were standing still. It was found on examination that a car near the east end of the line was coming down grade by its own volition, and at the same time furnishing the

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power to pull the other one up a part of the way. In other words, the motion of the wheels caused the motor on the down-grade car to act as a dynamo and produce a current of electricity, which was immediately contributed to the other car. Prof. Short expected this result, but did not know to what extent; hence the test. Great are the wonders of electricity. This feature of the system is manifestly of great value, as every car coming down grade gives back the power which has been put into it to take it up the hill, and helps to bring the other car up grade."

New Companies.—It will be seen from the list of new companies that several important companies have recently been formed. The largest of these is the "Metropolitan," with half a million of capital to start with. The directorate of this company is a large and influential one, and the names are those of gentlemen who are well known as directors of other companies which have achieved an acknowledged success, and nothing succeeds like success. The "Chelsea" company has been successfully launched, and has obtained the capital required. Another company which will have little difficulty in finding favour with the public is that of "Crompton and Co." This differs from the preceding, in that it is really a manufacturing company. As a private concern we have been familiar with its work from the earliest efforts, and all those who have been engaged in electric lighting work will know that the industry owes a large part of its present position to the intense energy of Mr. Crompton and his partners, who, through good and evil report, have never failed to believe, and lead others to believe, in the future of the work. We heartily wish these new companies all possible success. They are born under different auspices to their predecessors, so many of whom came quickly to an end. Greater knowledge has been obtained as to the work to be performed, and in regard to the methods and the cost of carrying out such work.

The Schanschieff Battery Syndicate.—The state of inaction on the part of this company has, we are glad to say, now given way to one of activity, under revised conditions of work. The matter, we learn, has been adjusted as follows: The proceedings by which the original syndicate was being sent forward for winding up (having sold out to the Schanschieff Company) were able to be stopped in time, and this syndicate has been revived with a capital of £10,000. The paid-up £200,000 of the company has been returned nearly in full, that is to say, less an amount of about half-a-crown a share expended in advertising, the syndicate standing to about an equal loss. A part of the capital returned has been reinvested with the Syndicate to the extent mentioned, and the payment to the inventor is readjusted in a corresponding proportion. Besides this the inventor holds a considerable number of shares, and will, therefore, share in a more justifiable manner in the profits, when made, of the company. It is understood that the Syndicate have already entered into negotiations for the Australian patents for a sum already exceeding their capital, and the Italian rights are also in negotiation; besides which, they hold patents in sixteen other countries. The Syndicate intend to commence active business in England at once, and, as will be seen from their advertisement, are enquiring for a number of skilled electrical workmen.

Human Electricity.—In the *English Mechanic* for last week a sketch is given of an instrument invented some forty years ago by Mr. Rutter to indicate the electrical action generated in human and other bodies. It consists simply of a glass shade in which a single silk fibre suspends a pendulum bob of wax, swinging clear of a circular piece of glass on the bottom of the stand, which circle of glass covers a paper marked with concentric circles. The neck is suspended through a hole in the top of the shade, and is carried by a brass arm springing from an unlacquered knob on the wood stand, and all wood and metal is free from varnish. To use it, the right index finger is placed upon the knob, and sundry movements are said to result in the wax pendulum according to the state of health and sex of the operator, and being stronger when several operators are connected in series. It is well known that Prof. Crookes invented the radiometer while experimenting for traces of electrical or other similar action of the human body, and as the action of the nerves is probably electrical or akin to that action, the tracing of an inductive effect under proper circumstances might be expected, and possibly even the effects of free electricity or magnetism, of either the usual or a more occult kind, might be perceived. We are not aware that anything really scientific has ever come of these experiments, but perhaps some of our readers may have heard of such experiments being performed with some definite result.

High Candle-Power Incandescent Lamps.—At the convention of patent experts recent held at Washington, U.S.A., appointed by the trade in order to discuss the validity of certain claims in dispute in connection with and relating to incandescent lamp manufacture, the award has been given to Shippey Brothers, Limited, of London, as assignees and sole owners of the Zanni-Shippey patents, No. 5,955 of 1883, and No. 11,802 of 1887, which combined patents are the only ones which describe a system for making high c.p. lamps for incandescent electric lighting. The assembly based their decision and report upon the following facts—viz.: That the inventions of Thomas Alva Edison clearly specifies that the object sought to be obtained by him was the production of an electric lamp of 16 c.p., with a view, as stated in the specification, to replace the ordinary gas-burner used at the date of the said invention, as the standard of light then adopted for commercial purposes. Whereas the invention of Messrs. Zanni-Shippey, which is clearly shown by the descriptive matter set forth and explained in the specifications, had also a special object in view — viz., that of producing an incandescent light burning in vacuo, of increased illumination and high c.p. as mentioned of 100 c.p. and upwards, described and printed in the patent specification. For comparison and as an analogy, the convention took as the basis of argument the ordinary commercial gas-burner and the Wenham lights, both of which systems of lighting had their special sphere and objects in view, as and for the purposes named, but covered under different inventions of a similar nature. The assembly also gave a certificate as to priority of invention for fancy striped and coloured lamps for decorative lighting to Messrs. Zanni-Shippey, for certain special designs explained by the drawings as affixed to the British, French, and Belgium specifications. This award is an important one, and by the recent decision of Mr. Justice Kay as to the validity of certain lamp patents it opens up a question respecting fancy lamps and for all lamps of 100 c.p. and upwards for incandescent lighting. Messrs. Shippey Brothers, Limited, announce that they do not intend to manufacture lamps, but will maintain their rights held under these patents; and in order to prevent

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complication and annoyance to users, they are prepared to grant licenses to manufacturers to make and supply same on reasonable terms of royalty.

Telegraphing to Trains.—At the meeting of the Railway Telegraph Superintendents, New York, on July 11, Mr. J. W. Lattig, on behalf of the Lehigh Valley Railroad, invited the association to take a trip to Easton over that line and inspect the working of the train telegraph in practical use. Mr. Lattig said that during the blizzard last March, it was their only reliance for telegraphic communication for three days. All the relief and supply trains were governed through the medium of the train telegraph, and its operators were on duty night and day. A serious accident occurred at this time, and there was no other means of communicating with the wreck. The wire was broken once on Monday at Bound Brook by other wires falling upon it. Their experience had been that this system works better in stormy than in dry weather. The use of it for commercial telegraphing was gradually increasing. None of the previously existing telegraph offices had been abandoned by reason of its introduction, because the growth of business on the road required constantly increasing facilities. A gravel-train had been equipped with the apparatus, which was engaged in the construction of an additional track. One hundred men were employed on this train, and during the first week one hour and forty minutes of time was saved by the train obtaining permission to remain on the main line. Working time for this train had been saved every week since it was fitted up and provided with means of constant communication with the dispatcher's office. All of the wrecking trains have now been equipped with these instruments, so that after being ordered out they are in communication with headquarters until the wreck is cleared away and the train returns. The guests were taken in a special car fitted up with the induction train telegraph apparatus for a trip over the Lehigh Valley road attached to the regular train. Mr. J. W. Lattig (who is superintendent of the Lehigh Valley road) took charge of the party, and an opportunity was given to the visitors to test the merits of the train telegraph. The length of time it has now been in use leaves no doubt as to its practical utility, not so much for the convenience of travellers as for constant use in the administration of the affairs of the company. Although the perfect reading of the signals is somewhat difficult at the outset to an operator not familiar with the sound, those who have had very little experience with the instruments have no trouble in copying long communications as readily as with the ordinary Morse apparatus. The exhibition was highly satisfactory, and gave a very good impression of the value of the system. We notice with pleasure the attention this method of communication is receiving from the railway telegraph-engineers in America. We think it is about time that a convention for the investigation of experiments of telegraphing to trains in motion was brought about among the railway telegraph-engineers of this country. These enterprising gentlemen are surely not going to let an important and time-saving invention drop out of sight for want of a little enterprise, but we are yet waiting to hear of the first application of the discovery in England.

Automatic Railway Signals.—The Pennsylvania Steel Company exhibited, at the recent meeting at New York of the Railway Telegraph Superintendents, a magneto-electric alarm signal for highway crossings, a hand semaphore signal, and a block system, which is the result and, in a measure, a combination of the other two. The distinguishing feature of all these appliances is that the electric current is generated from the power of the train by a dynamo of the magneto type, giving an alternating current and avoiding the use of cup batteries, which need a great deal of attention and are especially liable to get out of order by freezing. The generator or dynamo consists of from six to 12 large permanent steel magnets mounted in a strong frame, with a Siemens armature between the poles of these magnets. This armature by the undermentioned arrangement is made to rotate by passing trains, and thus an alternating current of considerable power is generated. Each wheel which has a tread wider than the rail, depresses a lever placed parallel and close to the rail and projecting above it from $\frac{1}{16}$ to $\frac{1}{4}$in. The motion of the lever compresses two strong spiral springs, and when the wheel has passed off the lever, these springs are released, and by means of a ratchet wheel an impulse is given to the armature shaft. This ratchet was designed especially for this machine, the motion being transmitted by a perfectly positive clutch for forward motion, and backward motion being accompanied by no noise and very little friction. A fly wheel gives steadiness and continuity to the motion derived from the impulses given by the passing wheels. A water-tight iron box, 16in. square and 13in. high, encloses the mechanism, and is placed far enough from the track to be out of the way of snow ploughs, &c. The armature shaft connects with the steel lever beside the rail. The same kind of dynamo is used for the highway alarm and the block system, and one of similar design, but operated by turning a crank, for the hand semaphore. There are no brushes or commutators to get out of order, and no batteries requiring renewal. The current thus generated can be transmitted any moderate distance, say up to six or eight miles, and there used to sound an alarm gong or operate a semaphore. A vibrating armature permits the use of the alternating current, which is one of the distinguishing peculiarities of this system. The motor and a semaphore or alarm gong are mounted on a post 16ft. to 20ft. high. The equipment for a crossing consists of two dynamos, usually placed from 1,500ft. to 1,800ft. from the crossing, and two posts, two motors and two bells, the whole costing less than £70. For use on single track roads a second lever is placed beside the rail, nearer the crossing than the first one, so that when a train is moving *from* the crossing this level will be depressed first, a switch turned, and no alarm sounded. The passage of a single wheel is sufficient to start the alarm, and after the passage of a train it continues to ring for some time, generally until the train reaches the crossing. In the block system the passage of a train throws up the danger signal at that point, and immediately afterwards throws down the danger signal at the preceding station, which may be several miles back. Thus, in no case can two trains get upon the same section if the signals are observed, for the warning cannot be removed at the beginning of one section until the train has passed on to the next one. One dynamo, and one motor, and semaphore will be required for each section. The cost will depend upon the length of section adopted. The semaphores can be so adjusted that an enormous force would be required to change their position by other means than that intended. This system has just been brought before the public, and is not yet in operation, but seems to be an important advance in automatic railway signalling.

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NOTES ON DYNAMO CONSTRUCTION.

BY SYDNEY F. WALKER.

(Concluded from page 73.)

Next, having decided upon the form of the armature, shall it be built of wire or discs, and how shall it be driven? It must be borne in mind that it is the wire on the armature which has to be driven. If that can be accomplished with good lasting results, mechanically, the core may be left to take care of itself, but the most efficient method of driving the wire through the magnetic field is by causing the core to rotate, and attaching the wire more or less rigidly to it; so that the first part of the problem is, after all, to drive the core. Some makers have taken a great fancy to iron discs fixed direct to the spindle, either strung on centrally, as in the Edison-Hopkinson, or dove-tailed on, as in the Crompton. There can be no doubt that mechanically such an arrangement is very efficient; but electrically, in the writer's opinion, it is not so. The remarks that were made with reference to Pacinotti discs apply here, though in a less degree. In the first place the Faucault currents are not so perfectly neutralised; or, to put it more correctly, the path of the Faucault currents, is not of so high a resistance as with the iron wire—with the latter, lamination is carried out in all directions. The E.M.F. at the periphery of the disc is higher than on the inside, and we know, in such cases, the current finds paths for itself within the disc. Further, one side of the circuit is by this means placed in conductive connection with the spindle and the body of the machine. So long as the insulation of the other parts of the machine remains perfect, and the E.M.F. low, this is not a serious matter; but if the insulation of any other part is defective, you have a leakage circuit open at once that will probably lead to burning of the bobbin, or part of it. Further, where high E.M.F.'s are used, this arrangement adds considerably to the danger to life from their use. There is only the cotton or silk covering of the wire, and whatever insulation may be used on the core between the one side of the machine and ground. Given a high tension machine, a man whose clothes are wet, on a wet night, standing on the ground, or even on a wet ladder, some distance down the circuit; the man with his naked hand, or a wet gloved hand, on some part of the conductor; and at the same time some change in the circuit, such as one or two arc lamps being turned in or out, and you have all the conditions for a very severe shock. The problem of the insulation of the machine from ground is one of the most important that will have to be considered when the question of transmission of power comes up for solution practically; and it becomes necessary to place high tension apparatus in unskilled hands.

Then as to driving. With ring armatures, if wire is used for the core; notwithstanding all that has been said against the old wood hub, properly constructed, and especially for bobbins of large diameter, it is by no means such a bad mechanical contrivance as it is made out; and, on the other hand, it lends itself to perfect insulation. Where, however, the bobbin is small in size and has much work to do, the wood hub is unreliable, as it is difficult to obtain sufficient grip. There is also some difficulty in obtaining wood properly seasoned and that will stand. The only resource is therefore to fall back on some form of spider to hold the core. In the Elwell-Parker machines, originally, brass bosses were driven into the spindle, carrying arms; and on these arms the core was wound, vulcanised fibre being placed between the core and the arm. The great objection to this was that the fibre had to drive, or at least to transmit the power. Vulcanised fibre is a substance that is subject to great changes. When dry, for instance, it is a fair insulator; when wet a bad one; and it also appears to undergo great changes in the presence of heat or electric currents, so that after a time it will lose many of its properties. This being so, it might be expected that the fibre would gradually give way, and as Messrs. Elwell-Parker have recently given up this plan, it may be supposed that some reasoning of the kind has held with them. Another plan is that of Mr. Kapp. It is a most significant fact that Mr. Kapp should revert to the wire core after having had full opportunities of knowing the advantages of the stamped disc system.

Mr. Kapp has worked out at some pains a special form of carriage for his core, which also includes an arrangement of horns for driving the wire in a positive manner. It is very doubtful, in the writer's opinion, if much is gained by this plan, while it adds considerably to the expense of construction. Further, should the core be saturated sufficiently to allow of lines of force passing through the centre, this carriage would become a source of loss by reason of the currents developed in it. Messrs. Crompton's method of dove-tailing their discs on to the spindle and the method adopted of stringing the discs of the Edison-Hopkinson machine, have already been mentioned. For drum cores generally there are many very good plans of driving, such as having two discs keyed on the spindle, one at each end of the core, and filling the space with wire. The plan adopted by Messrs. Paterson and Cooper for driving their Pacinotti bobbin is to string their iron discs together by three bolts, insulated from the core, and secured rigidly at each end to a stout disc or spider keyed on the spindle. This plan is better electrically than those generally adopted with discs, but is not so good mechanically, although it is only fair to say that it appears to work very well. Electrically, it is open to the objection that the wrapping or other insulation on the bolts is very liable to be worn through, and the core is then in connection with the body of the machine.

The methods of driving disc armatures have been indicated. The advantages and disadvantages of each form of dynamo—viz., single or double horse-shoe armature—parallel or at right angles to plane of field magnets have also been discussed; but a few words more on the multipolar dynamo may be of service. The principal objection to the multipolar dynamo lies, in the writer's opinion, in the increased expense of construction. There are so many parts, all of which require to be carefully fitted together. The connections between the armature and commutator are very much more troublesome to make, and therefore more expensive; there may be also two or more sets of brush-holders, and the magnetic resistance, as constructed by those who have adopted this plan, is apparently higher than that of other types. Further than this, the four-pole machines at present in the market, though they do their work well, do not, with the exception of that of Messrs. Elwell-Parker, appear to be mechanically as strong as other types.

Another point that appears to be worth discussing is, should the magnet bars of dynamos generally be solid or laminated? The writer observes that Mr. Fricker, in the course of his able series of papers on this subject, recommends the latter. On that point the writer would differ from him, and for purely mechanical reasons. He believes from what he has seen that the gain from the dissipation of heat is more than neutralised by the loss of mechanical strength and the increase of the magnetic resistance.

These notes would hardly be complete without some reference to the iron clad dynamo as it has been called. Its *raison d'ête* is as follows: When a current of electricity passes through a wire, we know that it creates lines of force which take the form of concentric circles round the wire. That is to say, any free magnet of small size brought into the neighbourhood of such a wire will place itself as a tangent to one of these circles. The result of this action upon a bar, or a ring of iron, or a series of magnetic conductors, such as rule in the ordinary dynamo, is to set up a continuous magnetic circuit in the iron and the space within which the wire on the armature revolves. Now, as we know, for any speed and number of turns, the E.M.F. generated in a given dynamo depends directly upon the number of lines passing across the space in which the wire moves, and this depends upon the exciting power divided by the magnet resistance. One part of this resistance is that of the magnet limbs, yoke, pole-pieces, &c., and the fact of our having to force the magnetic current through them, makes a charge upon the exciting power, and reduces the efficiency of the machine. If we can eliminate this resistance, we reduce this charge and increase the efficiency of

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the machine, and we may also, it is thought, reduce the magnetic leakage. The plan proposed is, in place of wrapping the exciting wire of the field-magnets upon bars of iron, and causing them to conduct the lines of force to the armature, to wrap the exciting wire directly round the armature, so that the magnetic circuit is composed only of the exciting wire, the air space, the revolving conductor, and the armature core. Now the question arises, can this be done economically, and what is hoped to be gained by it? It must not be forgotten that the iron bars round which the wire is wrapped perform two offices; they not only conduct the magnetism, but they form a portion, and often an important portion, of the framework of the machine. If we can magnetise our armature directly without giving rise to other sources of loss, and at the same time construct our machine as strongly and as cheaply in other respects, we shall gain not only in efficiency, but in the cost of the wire required to excite the field-magnets. In the writer's opinion, however, this is by no means easy of accomplishment.

THE CHARGE ON THE ATOM.

BY J. ENRIGHT, B.Sc., LOND.

According to the doctrine of Helmholtz, as expounded in the Faraday Lecture of 1881, each atom in a compound is attached to a definite quantity of electricity. The atom of iodine, for instance, in argentic iodide is attached to a definite quantity of negative electricity, and the atom of silver to an equal quantity of positive electricity. The atoms forming the molecule are cemented together by these opposite charges. When the attraction between the charges is overcome, the molecule is destroyed, and the elements are set free. Electricity is thus placed in an all-important and all-pervading position in Nature. It is an essential of the molecule—that is to say, of matter.

An unsuccessful experimental search for some evidence of the existence of these charges, together with the failure of the theory to account for ordinary chemical facts, constrain one to harbour serious doubts with regard to it. The basis of the doctrine is Faraday's "Laws of Electrolysis"; but even did it give a satisfactory explanation of the facts of electro-decomposition it could scarcely be considered ground enough for a theory of such scope and importance to rest upon, and I believe that as the subject comes to be more studied, the haste with which it was accepted will appear surprising. At the close of Helmholtz's famous discourse no less an authority than Sir H. Roscoe, the then President of the Chemical Society, gave it official sanction, and from that night to the present day "the charge on the atom" has been almost universally assumed. Nevertheless, scarcely any attempt has since been made to show how the common facts of chemistry, such as double decomposition and displacement, are explained by, or harmonise with, the theory. Neither has anybody, as far as I can ascertain, even discussed the weighty objections raised against it by Maxwell. It is proposed in this paper to fairly confront it with well-known facts and to give the results of experiments made with the expectation of elucidating it. The subject is inseparably connected with the theory of "dissociation," and the bearing of the one on the other will have to be treated.

It is established beyond doubt that when a current of electricity of sufficient strength is passed through an electrolyte, such as a solution of $CuSo_4$ in water, not only are the ions liberated at the electrodes but that there is an actual translation of them through the liquid. The exact mode of transference is still under discussion. The "orthodox," sticking to the theory of Clausius, teach that the molecules of liquids are in perpetual motion, and that the consequent encounters between them are so violent and jarring as to wreck some of them, setting free the constituent atoms or radicals, which nevertheless retain the charges with which Helmholtz has endowed them. The smallest current passing through such a liquid suffices to move anions to one electrode and cations to the other, but their actual ejection from the electrolyte does not occur until an E.M.F. of definite quantity is applied to it. Further, the wandering ions of Clausius are the only means by which quantities of electricity are conducted from one electrode to the other.

With regard to the theory of dissociation, it appears to me that a good deal of information may be obtained from a consideration of certain well-known reactions in which precipitates appear only after the lapse of time. For instance, dilute solutions of H_2SO_4 and $SrCl_2$ react, but precipitation does not occur until after an interval of six or ten minutes. Many other similar instances of slow precipitation are well known. Mr. Crooks has recently given instances of precipitation not taking place for hours after mixing the reacting solutions. I consider such facts at once an argument against the dissociation theory. A mixture of dilute solutions of strontic chloride and hydric sulphate is an electrolyte, and conducts well. A couple of Daniell's cells liberates gas freely from it; and therefore, according to theory, a host of wandering ions traverse it irregularly when a current is not passing through it. The ions are in two sets, oppositely charged. The members of each set repel one another, while the members of both sets are mutually attractive. Under such favourable circumstances for the encounter of the oppositely-charged ions, composing $SrSO_4$, it is very difficult to see why precipitation should not take place before so great an interval as six or ten minutes. When solutions of strontic chloride and hydric sulphate are concentrated, it is true that precipitation takes place far more rapidly; and it may be urged by supporters of "dissociation" that, after all, the facts are strongly in their favour, since with more concentrated solutions, and, therefore, presumably with a greater number of wandering atoms, the chances of encounter between the ions of $Sr\,SO_4$ are increased and precipitation accelerated.

As already indicated, the fact that a mixture of the dilute solutions conducts well disposes of this objection; but this is not all. The experiments of Kohlraush, Ostwold, and others prove that the conductivity of salts in solution increases with dilution. The "orthodox" are bound to interpret this as asserting that a greater number of wandering ions exist in dilute than in more concentrated solutions, from which it follows that precipitation ought to take place more quickly in the former. But the reverse is the fact.

The basis of this argument against the dissociation theory must be admitted by its supporters, for the experiment by which Prof. Lodge proved the actual transference of the ions through an electrolyte by the influence of the galvanic current must have been planned with the belief that oppositely-charged free ions moving about through a liquid do not fail to combine and form molecules. The experiment is described in the Aberdeen British Association report. One electrode and a solution of $BaCl_2$ were placed in one vessel, the other electrode and a solution of Na_2SO_4 were placed in a second vessel. Both vessels were connected by a long tube containing dilute HCl. and a current passed. After an interval of time a ring of $BaSO_4$ was formed at a considerable distance from either vessel in the connecting tube. I shall refer to this experiment for another purpose later.

Let us assume in favour of the supporters of "dissociation," that the slowness of precipitation from a mixture of solutions of $SrCl_2$, and H_2SO_4 is due to mere paucity in the number of free rambling ions traversing this particular liquid. What upon this ground will be the effect of passing a current through such a mixture during the period of apparent reaction before precipitation? When this experiment first occurred to me as likely to throw light on these matters, I reasoned as follows: There are two ways of figuring in one's mind the posture of affairs among the molecules of the mixture during the period of apparent inaction.

(1) The ions are straining—pulling or twisting—at one another. The forces in action are not very unequal, or the process being performed is a slow one—similar, it may be, to unscrewing. At all events the existing molecules of $SrCl_2$ and H_2SO_4 are in course of demolition in order to form the new molecules of $SrSO_4$ and HCl. If this be the real state of affairs and if the passage of a current through an electrolyte tends to break up its molecules, then I thought passing a current through the mixture during the period of apparent inaction should hasten precipitation.

(2) Through the mixture, according to the dissociation

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theory, a rather small number of free ions carrying the charges of Helmholtz are careering, and although the ions composing the $SrSO_4$ would eagerly combine at an encounter, such an event does not occur on account of their sparseness. If this be the real state of affairs, and if the passage of a current through an electrolyte tends to sweep the anions to one side, and the cations to the other, then I thought passing a current through the mixture as before should lessen the chances of encounter between the ions composing the $SrSO_4$, and so retard precipitation.

Here I had something in the nature of an *experimentum crucis*. Dilute solutions of H_2SO_4 and $SrCl_2$ were accordingly prepared. The concentration was such as to ensure precipitation in about six or seven minutes from the time of mixing. Equal portions of the solutions were mixed in a beaker, and equal portions of the mixture were placed in two smaller beakers of equal diameter. A current from five Bunsen's cells was passed through one portion of the mixture by means of platinum electrodes. A precipitate appeared in this in about three minutes. A trace of turbidity appeared in its counterpart in four minutes; but, for several minutes after, the greater quantity of deposit in the part through which the current passed was perceptible. I made similar experiments with solutions of nitre and tartaric acid, and a few other such mixtures, with confirmation of the result just mentioned.

I communicated the results of these experiments to Dr. Gladstone, and in the course of conversation he informed me that although they were not published up to that time he made the same experiments, but with a totally different object, many years before, and he read a paper on the subject at the British Association meeting of last year. The fact of the acceleration of precipitation is thus placed beyond question, and I submit that the dissociation theory and the Helmholtz theory cannot *both* stand in face of it. The precipitation of $SrSO_4$ from dilute solutions of H_2SO_4 and $SrCl_2$ is also hastened by heating or agitation, but as far as I can judge the arguments that may be grounded on these facts weigh pretty evenly on both sides. There remains to be considered, however, whether the heating effect of the current is not the cause of the more rapid precipitation which we have attributed to the current as such. I have made numerous experiments to clear up this point, and find that in all cases there is something standing to the credit of the current, apart from the rise of temperature it produces. I shall describe one which I consider decisive.

Equal volumes of rather strong solutions of tartaric acid and nitre were placed in a beaker and mixed. The mixture was divided into two equal parts, through one of which a current from five Bunsen's cells was passed for four minutes. The other was placed in a sand bath, and kept at a temperature of 48deg. C. for five minutes. The temperature of the first was raised from 9deg. C. to 21deg. C. during the four minutes the current passed through it. A comparison of the beakers left no doubt on the point. The deposit from the portion of the mixture through which the current passed was much greater than from its counterpart, although the temperature of the latter was 48deg. C., while that of the former did not rise higher than 21deg. C.

It appears to me that Helmholtz studiously avoided any reference to the dissociation theory throughout the Faraday Lecture, and, without being strong on the point, I feel that he is at variance—at least, as far as he expresses himself in his famous discourse—with the most "orthodox" authority on the subject. I gather, from the passages I am about to quote, that Helmholtz conceded to the electric strain the power of breaking up the molecule. He is arguing that there exists only the electric forces to bind the ions into the molecule, and says: "We must conclude, therefore, that no other force resists the motions of the ions through the interior of the liquid than the mutual attractions of their electric charges." Now, these "mutual attractions" are precisely what, according to Helmholtz, keep the molecules intact. Again, he says, "Even the feeble electric tension of two Daniell's elements acting through an electrolytic cell upon the enormous quantities of electricity with which the constituent ions of water are charged is mighty enough to separate these elements and keep them separated," And again, "At the surface of the electrodes decomposition can take place if there is sufficient electromotive power, and then the atoms can give off their electric charges and become electrically neutral." (Abstract of the Faraday Lecture, prepared by the author. "Nature," April 7, 1881. All quotations given from the lecture are from the same source.)

I cannot help contrasting this position with that taken up by Prof. Lodge: "All that a slope of polentia can possibly achieve in the interior of an electrolyte is to direct the procession of otherwise randomly moving atoms. This is, of course, the foundation of the theory of Williamson and Clausius, and all experimental knowledge acquired since the time it was first promulgated, with regard to the obedience of electrolytes to Ohm's law down to the research of Prof. Fitzgerald and Mr. Trouton, communicated in part to the last British Association, and still going on, tends but to confirm and strengthen the position."

Notwithstanding this disagreement with Helmholtz, Prof. Lodge stands fast by "the charge on the atom," and it appears a trifle inconsistent, if one may say so, of so high an authority to hold that the charged ions are driven unerringly in definite directions for great distances by the action of the current, while the same current is quite unable to affect the same charged ions when they compose a molecule. At all events, the current ought to cause the molecules to turn round and lie with the positively charged ions towards the positive electrode, and the negatively charged ions towards the negative, after the manner of a compass needle in a magnetic field. But if the current be vouchsafed this power, a tendency to break up the molecule is conceded to it, for the friction between itself and adjacent molecules during rotation would tend to tear the constituent ions apart.

Again, one is tempted to remark that it is not quite apparent how obedience to Ohm's law on the part of an electrolyte gives any ground for a belief in the theory of "dissociation." The resistance of an electrolyte may vary very irregularly, or behave in a different manner to metallic conductors, as varying currents are passed through it, and yet conform to the equation $C = \frac{E}{R}$ at every phase. If "dissociation" be a fact, the strength of the current must affect the resistance of electrolytes in another way besides altering the temperature. In fact, the quantity current must enter into the expression giving the resistance of a particular electrolyte under a given set of conditions. And were it proved that an electrolyte permitted the current to increase regularly as increments of E.M.F. were switched into an external circuit of comparatively low resistance through a certain range of difference of potential, but that at a definite value of current it stopped dead, and became for all further increments of E.M.F. as bad a conductor as turpentine, I should then begin to believe in "dissociation," for such, according to the theory, should be its behaviour, as I now proceed to show. The conductuity of a liquid has been proved to depend upon temperature and dilution, and it is not unlikely that other circumstances as well control this property. Every electrolyte, therefore, must be assumed by supporters of "dissociation" to have for *specified conditions* a definite rate—"a constant average of 'dissociation'"—at which free rambling ions get into it. For a particular electrolyte this rate is the limit of the rate at which electricity can pass across between the electrodes. Let us suppose this limit to be reached by choosing a current of suitable strength. We have now a steady flow of ions carrying across all the electricity brought to the electrodes by the leads. Every available free ion is occupied, and there is no provision for reinforcement, because, as we are taught, the current has not the power of dissociating. Neither can the quantity carried by each ion be altered, for that, according to Helmholtz, is fixed by the atomicity. If, under these conditions, the E.M.F. in the external circuit be increased, what is to occur? The current cannot possibly increase; so that, according to theory, it might very well have happened in the course of experiments on the resistance of electrolytes that a current was found in some cases to increase regularly as E.M.F. was added up to a certain limit, but that on this limit being reached, no further

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increase of E.M.F. could cause an increase of current. I have seen no account of such a phenomenon.

(To be continued.)

NEW MAGNETO BELLS.

The introduction of magneto-electric bells is of considerable advantage in many instances, as it obviates the use of a battery, with its many possibilities of getting out of order.

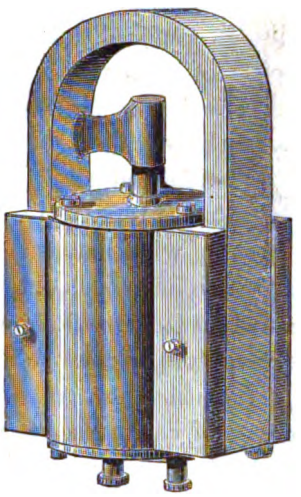

FIG. 1.

Several forms of magneto bells have been tried, but none seem to have met with much success. The new form

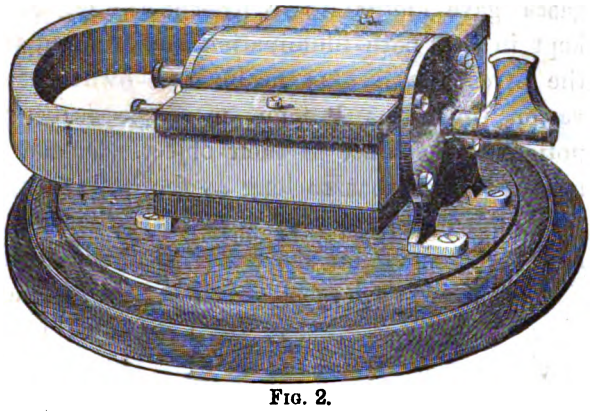

FIG. 2.

designed by Messrs. E. Cox-Walker and A. A. Campbell Swinton possesses features of interest, and well fulfils the

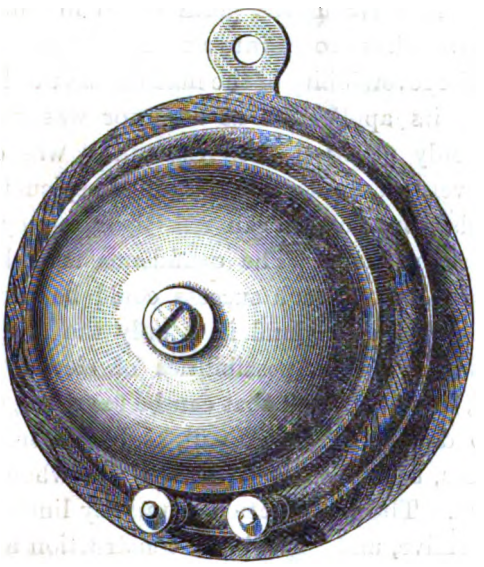

FIG. 3.

functions for which it is intended. Two forms of the generator as shown in Figs. 1 and 2, the former a fixed, the latter a portable form. It consists of a Siemens' armature working between the poles of a permanent magnet. The armature is worked by a thumb piece, and is so arranged as to have only a backward and forward movement, about a quarter of a turn each way. The current thus generated is sufficient to actuate the bell through some 500 ohms resistance. The bell can, as usual, be had of various forms. Fig. 3 shows a self-contained portable form. The core of the electro-magnet of these bells is polarised by means of a small permanent magnet, and the

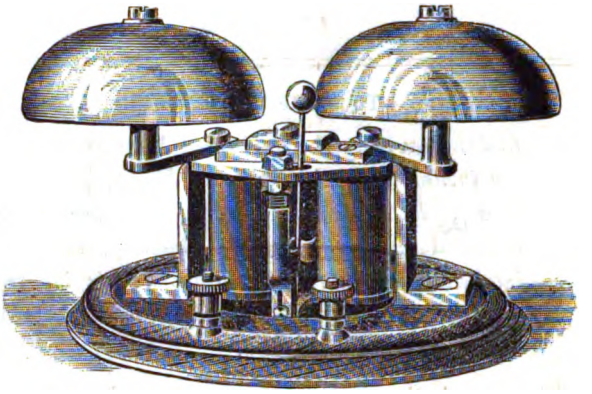

FIG. 4.

hammer strikes upon two slight prolongations of the gong rim, between which it vibrates. Fig. 4 shows a form with double gongs.

CORRESPONDENCE.

"NOTES ON DYNAMO CONSTRUCTION."

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—I have read with much interest Mr. S. F. Walker's papers on the construction of dynamos, but I think it will be in the interest of your readers if I correct a statement made by Mr Walker respecting the construction of the armature of the Gülcher dynamo.

The wooden centre, with charcoal plates on each side, with discs for gripping the ring and securing it to the spindle, has been discarded for nearly five years, because we found that:

Firstly. It was most unmechanical, as the armature slipped.

Secondly. It was most inefficient, as eddy currents were generated in the iron plates.

Thirdly. It was impossible to repair the armature without taking the whole machine to pieces and breaking every connection to the commutator.

Our first alteration was to make a gun-metal pulley with a central rib. Upon the gun-metal pulley we wound charcoal iron ribbon up to the full diameter of the central rib, and then turned off the top portion to a semi-circular form, so that there was no flat surface presented to the top of the pole-piece. This entirely prevented heating, and made the armature extremely strong and readily repaired in case of accident.

We have now abolished this plan, and wind the same pulley casting with charcoal iron wire, until the section of the armature core is square. In the small machines up to 20 unit the central gun metal rib is dispensed with, but in the larger machines the central rib has a number of slots cut in its periphery which hold the wire, and at the same time add extreme strength to the construction. Of course, the iron wire is wound on under a heavy tension, and we never find the slightest difficulty of any kind. We have no trouble from heating of the core, and the latest tests of our four-pole dynamos give 1 volt for every seven inches of active wire on the armature, the total amount of active wire being 56 per cent. This result is obtained at a mean periphery speed of 3,300ft. per minute.

I need hardly say that it will afford me much pleasure to show Mr. Walker one of our modern machines, when I have no doubt he will form a different impression respecting multipolar dynamos.—Yours faithfully,

M. MOUNTAIN, General Manager.

Gülcher Electric Light and Power Company, Limited.

London, S.W., July 28, 1888.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

TRAMWAYS.

The lengthy paper of Mr. Sprague read before the American Institute of Electrical Engineers, given elsewhere in our columns, again directs attention to a topic of the utmost importance. It is often said that Englishmen are apt to stand aside and allow others to prove the utility of a new invention or suggestion, then having seen it proved, we take it in hand and generally improve somewhat upon the original. This is especially the case when the original is a piece of mechanical apparatus. In the question of electrical traction the Englishman has not been particularly eager, but has been quite willing to stand aside and let his American cousin test to his heart's content. Mr. Sprague's paper tells us something of what has been done in America and the results which have been obtained. An investigation in the Patent Office will show that among the earliest ideas inventors had as to the application of electricity was its utilisation in some way or other for the propulsion of carriages. Some of the earlier inventors, as Pinkus, designed pneumatic systems wherein electricity was employed as an auxiliary, others, as Talbot, generated mixed gases by means of an electric current, and then by exploding the gases gave motion to a fly-wheel. De Moleyns kept in view both illumination and motion, and as the investigation gets nearer our own times the various inventors become more precise in their notions and definite in their object. Of course we now recognise that so long as the battery was the best known generator of electricity, there was no hope for its commercial success to obtain illumination or motive power. After all is said and done—after we have credited all who designed magneto machines or dynamos, the time had not come when these things were possible till Gramme produced his machine. From the initiative of Gramme the era denoting the modern progress of electricity takes its date. He gave us the germ which in the hands of improvers has grown into a colossal commercial tree. But the reversibility of the machine had to be noticed before its application as a motor was recognised. The only question then remaining was cost, and here venturesomeness was not conspicuous. Anyone else, but not us, can risk their money to prove success or failure. The confidence trick had to be repeated before such success could be proved, and even now in England it is only the few who are convinced of the possibilities of electric traction. That, however, is all that can be expected, and there is no doubt the leaven will, as heretofore in other matters, be sufficient to leaven the whole lump of inertia. The construction of railway lines has been progressive, and so will the construction and equipment of electric lines. Not long since we referred to a syndicate endeavouring to, or rather claiming to, control series working. We believe that quietly

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the whole of the English and American patents claiming anything in this direction have been obtained, and now belong to the syndicate, and, according to the prospectus, it is proposed to form a company in a month or two in order to exploit the series system in England. Again, it is rumoured that so far as the electrical arrangements are concerned, there is nothing to prevent the long-talked-of experiment upon the Metropolitan Railway, delay being caused solely by conflicting interests. Further, a contract has been, or is about to be, signed for the equipment by an English firm of a line of some twenty miles, while other firms are carrying out what may be termed exhaustive experiments for the information of tramway companies. It would be easy to describe an ideal town where electricity was a kind of universal provider—where, by its means, motive power was distributed in warehouse and street, where illumination came from a similar source, where neither horse nor mule had home or were required for labour. One advantage under these circumstances would arise in the simplification of street sanitation, and a great saving would accrue in the wear and tear of the streets. Mr. Sprague and others may labour to prove the direct saving that will come by the general use of electricity in traction, but we would also point out that the indirect saving is likely to be far greater than the direct, and the latter is an influence that may be brought to bear upon every household and ratepayer, while the former appeals rather to the pockets of the shareholder than to the community at large. If in a district the normal number of horses using the streets is, say, five thousand, and these be reduced one-half by the use of electricity, then the wear and tear due to the tramping of these horses is saved, and it is no stretch of the imagination to say the life of the streets is doubled, while the cost for cleansing the streets is reduced. Unfortunately, few people consider these indirect advantages. Most of us only understand direct advantages, and anything that puts a shilling into our pockets is appreciated, and will be heartily supported; while that which only helps by not taking out a shilling is lost to sight. Still, a few enlightened folk do recognise such advantages, and their support gradually brings with it that of their less thoughtful neighbours. Every effort, then, should be made by those interested in this branch of electrical engineering to see that those with whom they are brought into contact fully understand both direct and indirect advantages. Tramway companies may easily be considerable gainers, although the cost per mile run with electricity is equal to that where horse-flesh is used. In the construction of new lines, for example, the cost would be considerably lessened if an overhead system was used, though, unfortunately for electrical engineers, this cannot be done in the majority of cases in England. Even considering the extra weight of car and battery, when a battery has to be used, and the precautions to be taken in the construction to carry the extra weight, the wear and tear is practically confined to the rails, and not to the track, so that cost of maintenance of road is decreased.

PACINOTTI v. GRAMME ARMATURES.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—In his "Notes on Dynamo Construction," Mr. Sidney F. Walker refers to some experiments I made on the above three years ago. In my articles describing the results occur these words: "The function of the projections is to decrease the resistance of the magnetic circuit, and the condition of low resistance is, in this case, realised by bringing a portion of the armature core in close proximity to the poles." Again, occurs the passage: "The only electrical advantage to be gained from the projections takes the form of a diminished resistance of the air space for a given area of the polar surface." The object in view was thus clearly stated, though it depends on the construction of the machine whether the gain due to a diminished air resistance is large or worth securing. As a matter of fact, Messrs. Paterson and Cooper have been making their general run of machines with smooth cores for the past eighteen months, finding it better to increase the copper on the magnets than to tool out the armature projections. There are electrical reasons for making machines giving large currents with Pacinotti armatures into which I need not at the moment enter, but for ordinary types it is only a question of copper *v.* machinery.—Yours, &c.,

London, July 28, 1888. W. B. ESSON.

THE SOLUTION OF THE MUNICIPAL RAPID TRANSIT PROBLEM.*

BY FRANK J. SPRAGUE.

The presentation of this subject before the American Institute of Electrical Engineers for discussion seems to me most opportune. It is a question of great importance, and one for which a definite solution is fast becoming imperative. To those of us who believe that the solution is to be found in the application of electricity, it has a special significance, and I trust that what I say may bear fruit by starting a general discussion of the subject, not only among electrical men, but the general public as well.

More attention is now being paid to the question of tramway traffic than ever before. The reason is not only the comparatively high cost of operation under the present almost universal system of horses, but also because the public are beginning to feel, and the street railway men are beginning to see, that it is a system behind the times. Laying all humanitarian questions aside, the public demand a better and a more rapid service. Railway men want to give it, provided they can do so for the same or less money than they are now spending.

To quote from a New York evening paper:

"The rapid transit question has steadily pressed its way to the front of subjects demanding immediate attention, until it now stands in this city the foremost question of the hour.

"The fact is made evident by the eager discussion upon every hand of the very best means by which the end may be attained with the least possible delay. The total passenger traffic—that is, the total number of persons carried—of this city, has increased at the rate of 140 per cent. in each period of ten years since 1866, and is now something over 325,000,000. At the same rate of increase it would amount in 1890 to over 500,000,000, and in 1900 to 1,225,000,000."

There is every reason to believe that the through traffic will increase as much as expected, because the city is

* Read before the American Institute of Electrical Engineers, June 19th, 1888.

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growing rapidly and its business section is continually enlarging and pushing northward, forcing the larger part of the population, especially the labouring classes, to seek homes in the upper portion of Manhattan Island and the Annexed district, where rents, already increasing because of the increased facility of access, are still lower than can be readily commanded for business purposes in the lower part of the city. The elevated roads of this city, although carrying 500,000 people a day, do not answer the requirements of rapid transit, either local or through; nor is it possible for any two-track railway to do so.

By rapid transit we do not mean merely through transit; we ought not to consider alone the methods of transportation from one end of the city to the other, or from the city to the suburbs; we are likewise called upon to find some means by which the local traffic shall be benefited. Everything which lessens cost of operation, increases speed, reduces intervals between cars, increases the number of cars, and makes extensions possible, aids rapid transit, no matter whether surface, underground, or overhead.

With the same cost of operation, provided the motive power is materially cheapened, a greater number of cars can be run, intervals can be shortened up, large cars can be run in the place of small ones, better attention can be afforded, cars can be better heated, lighted, and cleaned, they can make better time, people can be carried further for the same money, branches can be opened in districts which would otherwise not pay, and, what is all important, more passengers can be carried, and for this reason alone more money can be made. For years an attempt has been made to replace the horse with motors of various descriptions—compressed air engines, fireless engines, hot-water and soda motors, naphtha and petroleum engines and steam engines. But we can safely say that the question has to-day narrowed itself down as between the cable and the various electric systems for surface work, and between electricity and steam for elevated or underground work.

In order that we may be in a better position to judge of the comparative economy and the relative advantage of present and proposed methods of traction, I will briefly consider, first, the use of horses.

Two distinct methods are recognised among street car men in the handling of their stable equipments. In one, the stock of horses is kept as low as possible; they are worked hard, making fourteen or fifteen miles a day, and the depreciation is very heavy. In the other, the stable equipment is increased; the horses are kept in excellent condition; their average daily duty is reduced to ten or twelve miles, and the depreciation is lessened.

Assuming the cost of a horse as 150dols., and the cost of feeding and caring for him as 180dols. per annum, it would seem that any accurate knowledge of the average life of horses under different days' duty would soon determine the proper amount of the latter.

All railway returns do not, strange as it may seem, give accurate information on which such estimates of cost can be made; but from such facts as are given we may deduce the following: Taking the returns for 1887 for the five largest roads in Massachusetts, we find that they show 6,909 horses and 1,410 cars; that the mileage made was 12,834,665, and the passengers carried 76,187,842.

Dividing the average daily mileage by the number of horses, and multiplying the number of horses in a team, we find only 10·26 miles as the average daily duty for all teams, sick or well. Horses which are on duty make from 12 to 14 miles. On the West End road of Boston, now the largest street railway combination in the world, having about 212 miles of track and over 8,000 horses, 10 per cent. of the horses are counted as being off duty from illness, sprains, shoeing or other causes; and the balance of the horses average about 12 miles a day. A car day is estimated at 10 to 11 hours, and from 45 to 50 miles, and eight horses are allowed as the active force.

The rule given me by one of the officials of this company as a fair one to determine a stable equipment is, to divide the total daily mileage by the miles made in a car day and multiply it by nine, adding what is necessary for hill horses. Hence, if 50 miles is a car day duty, a daily run of 1,600 miles would require a stable equipment of 288 horses, besides those for hill work.

On the Fourth-avenue line in New York, the stable equipment is determined as follows: A car day is 11 hours, and eight horses make about five trips, aggregating about fifty miles. To this number is added 10 per cent. for illness, sprains, &c., and 10 per cent. for emergencies. On this road is illustrated the influence of an important factor in horse car work—that is, the position of the stables. Horses from the upper stable are limited to eleven miles, or otherwise they would have to make twenty-two miles, while horses from the lower stable have to make about 13½ miles, or considerably more.

The average cost of motive power per car day throughout the United States, that is, for from ten to eleven hours, and trips aggregating from forty-five to fifty miles is about 4dols. This counts only those horses on actual duty on the road. The cost of motive power per car day for equal mileage in Richmond is less than 2dols. on the heaviest sort of grade work. The total operating expenses of a horse railway average for the five largest roads in Massachusetts 25.15 cents, and for all the roads in Massachusetts 24.7cents per car mile; and the ratio of operating expenses to gross receipts is, for all the roads, 86 per cent.

The cost per day per horse, based upon the returns of four of the largest roads in New York, is 54 cents, and the cost per car mile from 9½ to 10½ cents.

In addition to the regular depreciation, there is ever present danger of an epidemic in hot weather.

Since the cost of the motive power alone—that is, the cost of harness and stable equipments, horse-shoeing, renewals, provender, hostlers, &c.—is 40 per cent. of the total operating expenses, it will at once be seen how vitally important any material saving in the cost of motive power becomes. If, as we claim, the cost of motive power in an electrical system is one-half or less than that in a horse system, the percentage of gross receipts available for interest and dividends is more than doubled.

Furthermore, when we remember that the average running time for horses is only five to six miles per hour, we have another reason which consitutes an unanswerable objection to the use of horses for rapid transit.

Among the systems which have been proposed to take the place of horses and which has given the most promise, and met with the greatest success where heavy grades and traffic exist, is the cable system. With its general features you are probably familiar.

There are, however, a great many objections to it. One of the most serious is the great initial cost of the construction and plant, the cost of the conduit alone ranging anywhere from 50,000dols. to 80,000dols. per mile of single track, making the investment so large that none but roads having heavy traffic can permit of the expense.

The conduit is necessarily large and costly in order to accommodate sheaves of sufficient size to prevent too great a loss in friction, and on account of the position of the cable and pulleys it is difficult to clean it. This large size also makes it difficult to construct a conduit which will not, because of the traffic and weather strains, be distorted and have the slots forced together or apart. The depth varies from two to three feet, more often the latter, and in any city street this is almost certain to interfere with steam, gas or water pipes.

Each section of the line being a unit and operated from one cable, a break in the cable will suspend the entire traffic of the section.

A broken strand is apt to foul the grip and pile one car on top of another, as happened in Philadelphia, or suddenly start a car which is at rest, as recently happened on the 125th Street line in this city. The cable is a heavy, cumbersome affair, 1¼in. diameter, and weighs about 13,000 pounds to the mile.

It is found that it is best to make these cables in 20,000ft. length.

If a cable is stranded it cannot be used until repaired; if it is stretched 1 per cent. it is considered unsafe. These weaknesses of the cable system render it necessary to have a duplicate cable ready for instant use, and a double line of sheaves.

With a full load not over about 20 or 25 per cent. of the power of the engines is actually used for the propulsion of the cars, the balance being for moving the cable. With

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any light load the efficiency is even less. But it has been found advisable to have even greater power than this, most of the companies having from two to four times as much engine power as is required at any time, and from one and a half to twice the boiler power. This is necessary, because if any part of the cable engine breaks the whole section of the system is disabled.

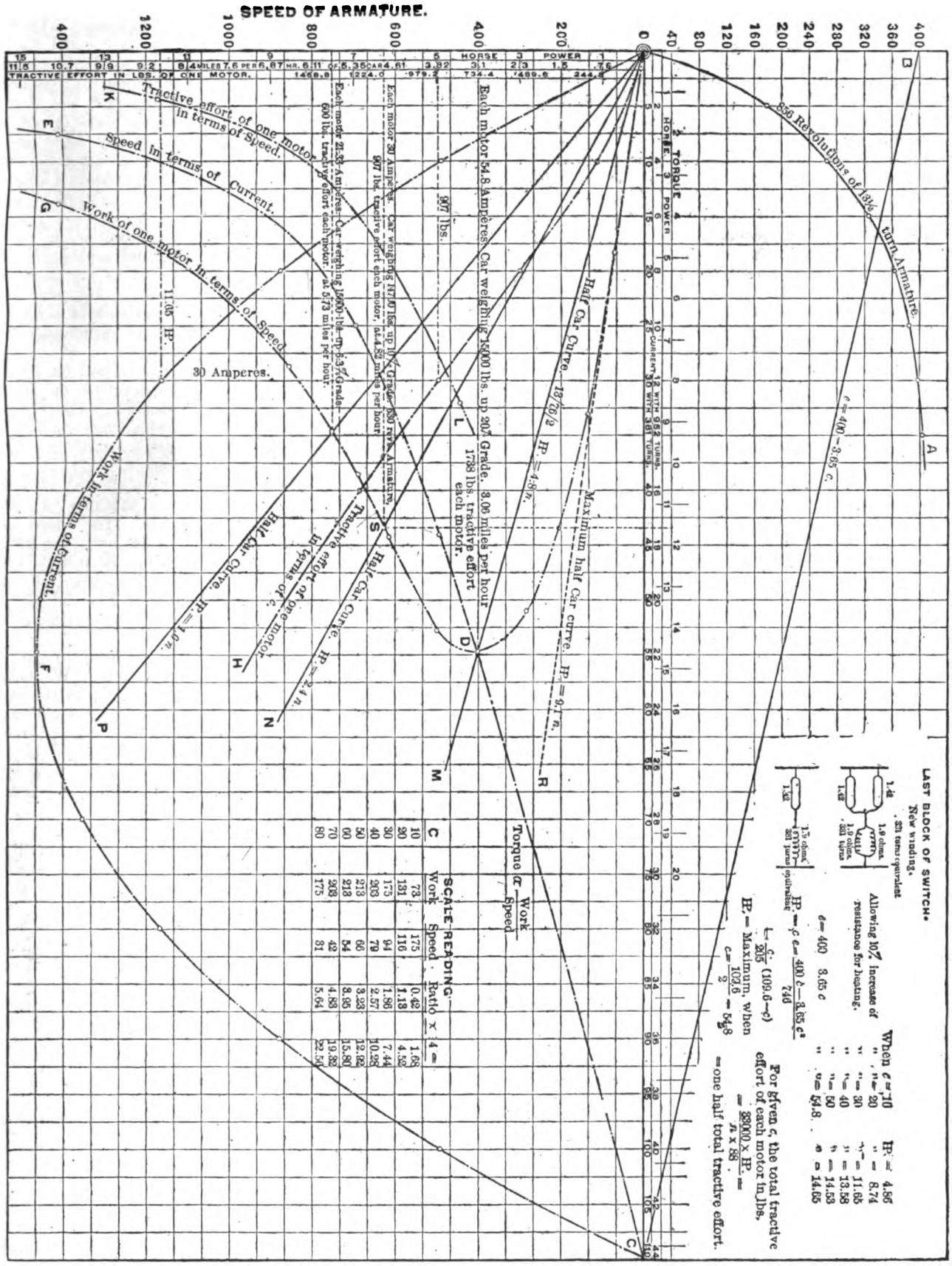
SPEED OF ARMATURE.
TRACTIVE EFFORT IN LBS. OF ONE MOTOR.
MILES PER HR.
CAR
HORSE POWER
Tractive effort of one motor in terms of Speed.
Speed in terms of Current.
Work of one motor in terms of Speed
Work in terms of Current.
Each motor 54.8 Amperes. Car weighing 15000 lbs. up 20% Grade. 3.06 miles per hour
1738 lbs. tractive effort each motor.
856 Revolutions of 18½ turn Armature.
Half Car Curve. 13/20/2 HP. = 4.8 v.
Maximum half Car curve. HP. = 9.1 v.
Each motor 30 Amperes. Car weighing 15000 lbs. up 10% Grade. 5.09 miles per hour
907 lbs. tractive effort each motor, at 4.83 miles per hour
907 lbs.
Each motor 21.82 Amperes. Car weighing 15000 lbs. up 3.5% Grade.
600 lbs. tractive effort each motor at 5.73 miles per hour.
11.05 HP.
30 Amperes.
Half Car Curve. HP. = 2.4 v.
Tractive effort of one motor in terms of c.
Half Car Curve. HP. = 1.9 v.
LAST BLOCK OF SWITCH.
New winding.
.321 turns equivalent
1.9 ohms
1.9 ohms
.321 turns
1.42
1.42
1.5 ohms
.321 turns equivalent
Allowing 10% increase of resistance for heating.
When c = 70 HP. = 4.86
" = 20 " = 8.74
" = 30 " = 11.65
" = 40 " = 13.58
" = 50 " = 14.53
" = 54.8 " = 14.65
e = 400 − 3.65 c
HP. = c e = 400 c − 3.65 c²
740
c = c/205 (109.6 − c)
HP. = Maximum, when c = 102.6/2 = 54.8
For given c, the total tractive effort of each motor in lbs. = 33000 × HP. / π x 88 = one half total tractive effort.
Torque ∝ Work / Speed
SCALE READING
C
Work
Speed
Ratio × 4 =
10 73 175 0.42 1.68
20 131 116 1.13 4.52
30 175 94 1.86 7.44
40 203 79 2.57 10.28
50 213 66 3.23 12.92
60 218 54 4.03 15.80
70 203 42 4.83 19.32
80 175 31 5.64 22.56

FIG. 1.—Curves Illustrating Electric Railway Motor Characteristics.

Every turn in a cable brings a strain upon the grips and reduces the life of the cable, and any increase in the speed at which a cable is driven likewise shortens its life.

Difficulty exists in turning corners, expensive drums, and oftentimes auxiliary cables being required. Constant care and attendance is necessary in lubricating the carrying and curve pulleys, and in taking care of the slots and switches, the estimates for Boston being about 3.20dols. per day per mile of single track, requiring the time of one man per mile. It is impossible to work turnouts, cross-overs or sidings without auxiliary cables, or to operate single tracks.

A line once being put in, any extension is expensive and difficult because of the terminal machinery which is necessary and the definite length of the cable.

The speed is limited; a car cannot travel faster than the cable and thus recover lost time, except on down grades; nor can it travel more slowly save by permitting the cable

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to slip. The regular speed, then, must be the same in the most crowded sections of the street as in the less populated sections.

The starting is often with a jerk, and the whole motion of a lurching, unequal, unpleasant character, exceedingly disagreeable when first experienced.

Success in the cable railway system considered by itself depends largely upon the condition that a line of reasonable length shall be so located as to warrant frequent car service.

The chief advantages of a cable are the cheapness, as compared with horse-power, of operating a heavily patronised road at a comparatively fixed rate of speed with no regard whatever to grade or gravity; but this cheapness is not inherent to the cable system, but due rather to the fact that steam has such a tremendous advantage over horses. The motive power operating expenses vary from 50 to 70 per cent. of the cost of operating by horses.

Now, what is it electricity by some of its systems promises us for the ordinary street traffic? What are its advantages? First, it will do the work, and in a far more satisfactory manner and at a greatly lessened cost of operation than with horses. Electricity is simply an agent for which we have to pay a certain proportion to carry the power of our steam-engines to take the place of the horse. Since not only on levels, but also on the up and down grades, an electric car can be run much faster than a horse car, and because it can be got under way and stopped much more quickly, the mileage with any given number of cars can be increased, the mean running speed increased, and the same time intervals made, with a less number of cars; or, on the other hand, shorter intervals be made with a given number of cars. The equipment will occupy about 35 per cent. less space, the horse space being saved; and this fact, together with the ability to back when necessary, and to quickly gain headway, enables an electric car in narrow and crowded streets to work a passage through where horse cars would be at a dead standstill. Not only can cars run down grade faster, but also with much more safety, because of the possibility of the instant reversal of the motors in the event of the parting of the break-chain; and when arriving at the top of a grade, the faster a motor runs the better. It has not got to be held in to save it.

The riding of an electrical car is far easier than that of any cable or horse car, starting and stopping more easily, and being in a large measure free from lurching and oscillation. The cars are much cleaner. They can be brilliantly lighted, and they can be heated by electricity. There is no dust, such as rises from the heels of horses. The sanitary conditions are entirely altered, and the health and comfort of the whole population is conserved. Stables with all their unsavoury characteristics and the consequent depreciation of the value of adjacent real estate disappear. No sand is needed on the pavements, and the pavements are not so quickly worn out; often no centre paving is necessary. It becomes feasible to operate branch lines, and also combinations of grades, curves, and ill-conditioned streets, which would be prohibitory to any other system. It is not to be claimed that any one system of electric traction has all these advantages; but in some form or other they will be found.

It has been said that an extended system cannot be operated by electricity, that the lines may break down, that a large number of cars cannot be operated simultaneously, especially when bunched up, that wires burn out, that brushes burn up.

True, these things have happened, and in case of defective workmanship or carelessness they may happen again. Although electricity is a force of unknown nature, and we know it by its effects, it is folly to hold that, whatever faults in machinery may exist or accidents occur, they do not come within a very narrow and limited category; and powerful and mysterious as it is, and answering an impulse with the rapidity of lightning, it is at the same time the most tractable and law-abiding agent with which we have to deal.

There is not a freak of which it is capable which we can not guard against. It has not an attribute of which we cannot make positive use. It has no power of damage which cannot be controlled.

The development of its application, the mistakes which have been made, and the accidents which have occurred are but the milestones and guideposts of the highway to success. Were it not for the occasional failures there could be no advance.

As a matter of fact, there is no apparatus for the transmission of energy that compares in simplicity and efficiency with the dynamo-electric machine and the electric motor. There is no machine in existence, which, when thoroughly and well-built and decently cared for, is less liable to get out of order, and will stand harder usage and greater variations of work with a minimum of attendance and care. A motor has but one moving part, and that has a rotary motion. Its torsional effort under given conditions is a constant, and when properly built and proportioned some types have over a wide range the remarkable and unique quality of having this torsional effort vary as the square of the current used, a feature of marked importance in traction work.

As modern as the motor is, the peculiarities of all its phases are just as well known and capable of just as graphic representation and forecast as are those of the steam-engine. This can best be shown by reference to some curves which illustrate the characteristics of some of the Richmond motors, and have the same significance that an indicator diagram has for an engine.

For convenience, these curves are plotted on both sides of the axis of X, Fig. 1. The ampere-turns on one leg of the field-magnet are plotted as abscissæ. The curve O A gives the characteristic of the machine when run as a series dynamo on a variable external resistance at 856 revolutions. B C represents the equation of counter E.M.F. with an initial E.M.F. of 400 volts. I have allowed an increase in the actual resistance of the machine of 10 per cent. for heating and other causes. The speed of the armature, the miles per hour made by a car with the Richmond gearing, the tractive effort in pounds for one motor, and the h.p. units are, for convenience, all laid off as negative ordinates. Equal units of h.p. and torque are laid off as abscissæ, so as to make the maximum points coincident.

The first report and curve which we have to get is the speed of the motor in terms of its current. We have the law that the speed is directly proportional to the counter E.M.F. developed, and inversely proportional to the strength of the field. In other words, the speed curve, E D C, in terms of the current, is plotted from the curves O A and B C, and the speed for any current is found by multiplying 856 (revolutions) by the ratio of the ordinates corresponding to the current.

The next curve with which we have to deal is that of the work of the motor in terms of the current; that is the curve O F C, which intersects the axis of X and at the same point as the curves of speed in terms of the current and the counter E.M.F.

A third and most important curve is that of the work of the motor in terms of its speed, which is the curve O D G plotted from the curves E D C and O F C, with the horse-power units transferred to the axis of X as abscissæ. For instance, following the regular ordinate for 30 amperes, we find, at the proper intersection, a speed of 630 revolutions of the armature, or 4·82 miles per hour of the car; and, at the intersection of the work curve, that 11·65 h.p. is developed. These two values give us the point S as one of the points of the work curve and so on.

Referring to the work required to be expended on a car, we have from the formula:

$$\text{h.p.} = \frac{w\,n}{375}\left(\frac{k}{2{,}000} + \sin\theta\right),$$

where w = wt. in lbs.;
n = miles per hour;
k = resistance to traction in lbs. per ton on level;
θ = angle of grade.

This gives the work which is required for any grade, speed, and weight. Hence, for any given conditions we can plot the equation, h.p. $= a\,n$, and by its intersection with the curve O D G find at what speed the car will be moved by the motors, and what current is required, if we know the gearing. On the other hand, if we assume that a certain

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load on a certain grade shall be handled, and we elect that it shall be done with a certain efficiency of the motor, or on a certain part of the work curve, we can draw the car curve for this intersection, and then deduce the speed of the car and, from it, what must be the ratio of gearing to enable the car to be handled by the motors under these conditions. Four of such car curves are drawn—O R, which shows the maximum which could be moved; O M, which shows what can be done at 50 per cent. efficiency; O N and O P, showing the equations which are constantly used in practice. In the actual computation 10 per cent. extra is allowed for losses from friction and so forth.

With the Richmond gearing, and a car equation, h.p. = 4·8 n, we would have a car weighing 14,700lb. sent up a 10 per cent. grade at 4·82 miles per hour, and each motor would take 30 amperes of current. If the grade or weight were increased, the curve O N would be carried towards O M; or, if the ratio of gearing is changed, then, with the curve O N in its fixed position, the weight of car or the grade could be increased, although the speed of the car would be reduced. Other curves are shown; L K showing the tractive effort of the motor in terms of its speed, and O H showing the tractive effort in terms of the current; the tractive effort varying, of course, as the work divided by the speed.

The variety of problems which can be worked out from these curve sheets is very large, and they become of vital importance in dealing with any new work. Nothing could show more clearly the value of a mass of iron in the field-magnets (as I have always held to be the proper method of building motors), and the exceptional qualifications of motors for tractive purposes. Any change in the switch or any change in the potential will vary these curves materially. One fact, however, is to be noted. No matter how the field may be changed, the speed of the motor at 50 per cent. efficiency is a constant.

The connection of the motor to the driving wheels has been attempted in a great variety of ways, and nearly every mechanical device possible has been used. Often the motors are carried upon the car body and connection made with the wheels, which should bear a variable position relative to the car, by means of friction wheels, sprocket wheels, and chains, or by belts, ropes, or wire chains with tightening devices. The motor armature has been mounted directly on the axle, and also hung on a frame between the axles, being connected to both wheels by cranks and side rods, necessitating equal speeds of revolution of the motor armature and the wheels.

These methods are all crude and unsatisfactory. They are makeshifts, and ignore the most important and essential facts which have been developed in car and motor construction. There is, to my mind, only one good way to connect a motor, and this is to centre the motor upon the axle, supporting it flexibly from the car body or the car truck, and driving by gearing with one or two reductions according to the service which is demanded. This is the only way in which an absolutely safe and positive connection can be depended upon both for ordinary work and for the normal and sudden strains called for in an emergency.

Properly made, the friction of this method of reduction is very low, the motion is smooth and free, and reasonably noiseless.

The proposition to couple the motor so that it shall make the same number of revolutions as the axle, ignores one of the most important points which makes light weight in motors possible, and that is the high speed at which the armature can be run.

I have pointed out, in describing the curve characteristics of a motor, one of the essentials to determine the proper ratio of reduction for any motor when required to do a given work. I may here add a brief formula, which will also serve as an index in this matter:—Let f equal the maximum velocity in feet per minute at which an armature at any time is allowed to travel; n, the number of miles per hour to be made by the car; D, the diameter of the car wheel in inches; d, the diameter of the armature in inches. Then the ratio of the gearing must be expressed by the equation—

$$R = \frac{f D}{88 n d}.$$

For instance, let $f = 4{,}000$, $n = 12$, D = 30, and $d = 10$—*i.e.*, about the values which exist in street car work. Then

$$R = \frac{4{,}000 \times 30}{88 \times 12 \times 10} = \frac{125}{11}$$

and this should be made in two reductions. As in our largest trucks, let $f = 4{,}000$, $n = 35$, D = 42 and $d = 18$. Then,

$$R = \frac{4{,}000 \times 42}{8 \times 35 \times 18} = \frac{100}{33}.$$

In the application of electricity we are limited to no one system; we have a choice which will permit us to meet any exigencies or conditions of traffic. There are two kinds of application.

In one each car is perfectly independent of the other, receiving its charge at the central station and acting as an individual unit. The storage battery method is such a system.

The other is a system of direct supply, and unlike the battery system, where the energy of the steam is four times converted, it suffers only two losses. In this system the current is delivered directly to the line, from which the motors as they move along derive their current. There are several forms of conductors, centre, and side rails, the main tracks, conductors carried in conduits, and overhead. Either a complete metallic circuit may be used, or one conductor with the rail and earth return. The machines can be operated under three different systems—the series, multiple series, and parallel circuit distribution.

Of these various plans, I shall discuss only three—the storage battery, the conduit and the single overhead wire system with underneath contact carried on the car, and for the systems of distribution the parallel circuit system only.

The storage battery, from the time of its first introduction to the public, has offered a tempting solution to the application of electricity for surface transit. The great advantage of the battery system is that, while most of the advantages of an electric system are retained—such as perfect control of the car, ease of manipulation, cleanliness and so forth—each car in itself becomes an independent unit not dependent upon any general accident to a system. As attractive a solution as the storage battery at first sight seems, there are many points of disadvantage in the present state of its development. One of the most important is the excessive weight of battery which is necessary under the conditions of service which are met with in this country, from 3,400lb. to 4,000lb. being the ordinary weight. Not over 10 per cent. of the lead in these batteries is actually used for storage. On account of the weight and the room which the battery takes up, there has to be a radical change in the construction of the cars; and while old cars can be made use of by a great deal of patching, it is not advisable to attempt this. This change makes the present cars useless, and likewise increases the cost of new car bodies.

Then again, while the tracks as they exist may stand the additional weight of motors on a four-wheel car, the additional weight of battery, making the total weight on a given wheel-base double what it was before, will render it necessary on a great many tracks to relay the road-bed or to put in 8-wheel cars. Of course these objections are not so serious on a new road as they are on an old one.

But I confidently expect to see, in the not so very distant future, the weight of battery necessary to handle a car reduced one-half; this, besides overcoming some of the objections which exist now, will halve the expense of handling them at the central station, and will also allow the present standard width of aisle to be maintained.

The present excessive cost and unknown depreciation of the battery, its lack of efficiency, limited capacity, the fact that only a portion of the charge can be taken out with safety, and the reduction of its output when sudden demands are made upon it, are all of such a character as to leave wide room for improvement. The loss of efficiency in conversion I do not esteem of such vast importance, because in any large system where the engines are kept going under a steady load, the cost of operation will not be so very much more than where operating under continually varying loads. The limited rate of discharge, as well as the limited

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capacity, limits the grade work to which a battery car can be subjected. For instance, as batteries and cars are now made, we can easily have the following combinations of weight:—

	Pounds.
Weight of car	5,000
Batteries	3,600
Motors and other apparatus	2,000
Sixty-five passengers	9,100
Total	19,700

To start and to accelerate this load on, say, a 6 per cent. grade, demands a discharge rate which no storage battery company cares to recommend.

As near as it is possible for us to get at a correct estimate on a new road of moderate grades, a storage battery system could be operated at about 80 per cent. of the cost of operation by horses. This is about double the cost of the direct system of supply on a large scale.

But the storage battery is not going to stand still.

Many men with abundant capital are striving for improvement, and I think there is but little question that batteries will be reduced in weight, increased in capacity, and made far more efficient and long-lived.

The conduit and overhead systems have one point in common. Both are dependent upon a central station, and the actual cost of operation (except for the care and maintenance of the conduit itself) would be about the same. There is, however, a great difference of investment. Both must have about the same amount of copper, and, to be effective, about the same distribution.

The difference of cost, then, is practically the difference between pole erection and conduit laying, and this will be from 25,000dols. to 30,000dols. per mile. As an investment, of course, it means that with the conduit very much more money has to be earned. The electrical conduit can be built for less money than a cable conduit, because it can be made of less depth, but it cannot be built without due regard to the strains of street traffic and weather, and with proper drainage and cleaning facilities. The advantages of the conduit are chiefly that there are no overhead obstructions. Its disadvantages are, besides its great cost, the lack of cleanliness, increased possibilities of leakage, and greater difficulty of repair in case of accident. Recognising, however, the demand which exists in certain places for a conduit, we have developed such a system which has many of the same elements of simplicity and reliability that our overhead system possesses.

The working conductor carried in the conduit is divided into sections, which at intervals of every block or half block, as desired, are connected through automatic cut-outs in manholes to the main conductor, which is continuous and enclosed in a lead or iron covered cable. Any accident to a section, such as flooding, short-circuiting, and so forth, will simply cut out that particular block.

For the immediate solution of the question of more rapid and cheaper transit in many places the overhead system is most available.

I am aware that a great hue and cry has been raised, especially of late, against any electric wires whatsoever being used above ground. The feeling which exists is not entirely unreasonable; in fact, it is easily accounted for by the most casual inspection of the condition of the wires of this city. But many of the objections which are raised against all overhead systems are not necessarily inherent; they are very largely due to gross carelessness in construction engendered by a faulty municipal administration. We have in our cities little or no active control or oversight of the wires which have been put up in our streets. Year after year, from the earliest telegraph days, those in control have granted to telegraph, electric light, telephone and electric power companies innumerable more or less limited franchises for stringing or hanging wires through our streets. These permits have often been granted without any restriction whatever; they are often granted for a "consideration." The erection and maintenance of these lines being a large factor in the cost of construction and operation of the companies, they have been put up with little or no regard to public convenience or safety—certainly with no regard to any æsthetic tastes—and oftentimes with an utter ignorance of the proper methods of construction. Fire-underwriters, in their wisdom, have demanded an insulation to stand fire, forgetting, or in apparent ignorance of, the fact that protection from moisture and leakage is of far more vital importance. Hence we have that treacherous wire known as "underwriters' wire," or more commonly among electricians, "undertakers' wire."

The poles have, until lately, been of the cheapest construction, badly set and continually marred and weakened by the spurs of the linemen. New lines have been continually added, and poles intended originally for a certain number of wires are now carrying double or treble that number.

The electric light companies, after cutting out a lamp for which a contract has expired, leave the bights of their wires hanging in loops. The telegraph and telephone companies allow thousands of miles of "dead" wires to remain overhead, or to hang in festoons from every pole, which in some sections are utilised as clothes-lines or are used by the street urchins as kite traps.

They cross and recross the street at every angle, every elevation, and at every tension. They are strung surreptitiously on poles to which no right exists and over buildings for which no permit has been granted.

No one seems to have the power to compel a change or improvement in these practices, and the companies themselves never will do it until so compelled. The sharp competition in the lighting business, the small profits derived therefrom, the great trouble of hauling down and getting rid of miles of dead telephone and telegraph wires, all these interfere with a satisfactory straightening out of the existing system of overhead wires.

In all improvements for public convenience we have to consider the arguments for as well as against such improvements. It is not sufficient that we say that there are disadvantages attending the introduction of the system, but we must consider likewise the possible advantages; and this is especially important when we consider the use of the overhead line in a system for propelling street cars. Such a line being part of an investment of a company which has practically no competition on its own streets, and whose own interest would require it to keep its line in first-class condition, can be put up in a manner presenting few of the objections which are generally urged against a system of overhead wires. I would not urge its adoption for all places, but in all suburban districts; for comparatively narrow streets, for all streets operating under an elevated railway structure, or where the tracks are near a side walk, the direct system of supply from an overhead line with underneath contact, presents advantages which, once appreciated, far outweigh the possible objection of such a system.

Several methods exist in which the wires can be erected. One in which span wires, at a distance of 125ft. apart, reach across the street from building to building, or from pole to pole, and has suspended from it, directly over the track, at a height of about 19ft., a longitudinal wire of not more than a quarter of an inch diameter, this wire being termed the "working conductor." This should be of the very strongest character. It should have a high elastic limit, great tenacity, and resist corrosion and oxidisation.

Its conductivity is a matter of less importance, since not upon it, but upon the main conductor which supplies it, do we depend for the main transmission of our current. Hence the elements of strength and reliability are of far more importance than conductivity. We have found that the best wire for this purpose is that alloy known as "silicon bronze"—a wire which can be drawn for a tensile strength of from 75,000lb. to 150,000lb.: that is, a strength higher than that of the best commercial steel. Such a wire it is almost impossible, under conditions of service, to break, and its life is very long. Samples of hard-drawn copper wire, which possesses only from one-third to one-fifth the tensile strength of this wire, show, after months of the severest usage, scarcely any signs whatsoever of abrasion or reduction in size. This wire is of the same size, whatever the distance run or the number of cars operated, and the main conductor may be stretched along the buildings, through a side alley, along poles, underneath the elevated structure, or buried underground.

In the latter case there would be in a single-track street only one longitudinal wire, and that one over the track,

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and it would be no larger than a single telegraph wire; and in the case of a double track there would be only two wires stretched longitudinally along the street, and these would be as taut as harp strings.

Switches and cut-outs are put in main and working conductors in such a way that the different sections can be operated independently, and cut out automatically or at will. The span wires can be as much above 19ft. from the ground as is desired. Of course, where a telephone or electric light line crosses the street, and may break and fall upon such a conductor, it would be necessary to have one or two guard wires above it.

These guard wires can be very properly carried from the span wires themselves. Furthermore, if desired, the stretches between the span wires where the guard wires are used can be very much longer than 125ft. They can be even as long as 500 or 600ft.—that is, two or three city blocks—in which case the two guard wires form a light suspending structure, from which, at intervals of 100ft., the middle wire is carried in a straight line.

In very many cases, it is unnecessary to have any span wires whatsoever. In those streets where the track runs near the kerb, a light pole with an ornamental bracket is all that is necessary.

In a broad street, where the tracks occupy only a small portion of the street, and are near together, a line of poles of ornate design, with light arms projecting on either side, can follow the centre of the street. Oftentimes, there is a middle division or park, such as exists on the Boulevard in this city, which will afford space for the poles without interfering with anything. These same poles can be used for lighting the street. On streets occupied by elevated railroad structures, the structure itself can be used as a support for the overhead wires.

Among the numerous places in New York where an overhead system could be put in perfect operation are Eighth-avenue, from Fifty ninth-street up; the Boulevard, from Fifty-ninth-street up; a part of the First and Second avenue lines; the Third, Sixth, and Ninth avenue lines, and all the suburban extensions in the annexed district.

To avoid any extra strain on this wire, the current is taken off by a flexibly-supported trolley carried on the car, and making contact underneath by upward pressure, as will be more specifically described later.

With such a system put up in the proper manner, it is almost impossible for any accident to occur which will disable the line or prove a hindrance or annoyance to the public in any way.

The wires are perfectly clear of the operations of the firemen, and should they in any place interfere the obstructing section can easily be cut out without disabling the remainder of the system.

The question of "E.M.F.," or electrical pressure, so to speak, to be used, is one of great importance. I do not favour going above 400 volts, and this on a continuous current circuit. This is less than one-seventh the E.M.F. which exists on many of the arc light circuits in this city; and the current being of a perfectly smooth and continuous character is free from the danger which might be feared from a current of equal E.M.F. of the alternating or pulsating character. In point of fact, in Richmond, a very large number of our men have received the full E.M.F. from our line without any injury.

On a dry day, the trolley wire has lain coiled up on the ground while the cars are in operation; and while certain changes were being made in the overhead circuit, the men work continually with the current on the line. I have never known a constant potential current of 400 volts to cause of itself the death of or serious injury to a human being.

The past year to me has been one of great responsibility and wide exerience. It has been a hard year. But the experience and expense are as nothing compared with the great value of having been with my associates instrumental in bringing to a successful issue one of the most important pieces of electrical engineering with which I have ever had anything to do. Among the roads which we have equipped the most important is, of course, the Richmond Union Passenger Railway, which now has six times as many machines in operation as any other road of its character in existence, at which every difficulty to be encountered in an overhead system on heavy grades and with sharp curves has been met, and which has for all time conclusively settled the question of the economical operation of a large road by the method of direct supply.

I will briefly refer to the road, giving some illustrations of its principal features, and some facts about its operation.

Some idea of the character of the road may be gathered from the following: The total trackage is about twelve miles. It runs a very irregular course and reaches the principal parts of the city. About nine miles of street are covered. The central section is a double track for a distance of something over two miles, a part being laid on paved streets, and the balance on macadam or unpaved streets; all the extension and branch lines are on unpaved streets, many of them in clay soil, which, in wet weather, covers the tracks, and where it would be an impossibility to operate horses without paving. The double-track section partly encircles the old State Capitol, and presents difficulties rarely equalled elsewhere. This part of the line, in a distance of less than 1,000ft., has, on both east and west-bound tracks, four curves, the inner rails of the west-bound track being of about 27, 30, 40, and 50ft. radius. The power necessary to run these sharp curves is much increased by the fact that grades are encountered on the curves as high as 8 per cent., and the lay of the street has required some of the outer rails to be some inches below the inner ones. Running eastward from the Capitol, the road descends to a low valley through a series of grades, varying from 3 to 10 per cent., and then ascends a series of sharp grades and curves in a new district to one of the car houses.

Going west from the State House, the road rises to nearly the highest point in the city, and then runs through a residential district across the Richmond, Fredericksburg, and Potomac Railroad, and, after several sharp curves, extends back a further distance of two miles to a second car-house beyond the new reservoir. Two branches connect with its main line, one leaving at the old Market Place crossing, and paralleling the Chesapeake and Ohio Railroad, and terminating at its machine shops. The other runs into what is popularly known as "Africa," a section almost exclusively inhabited by coloured population.

(To be continued.)

COMPANIES' MEETINGS.

ANGLO-AMERICAN TELEGRAPH COMPANY.

The half-yearly general meeting of the Anglo-American Telegraph Company, Limited, was held on Friday last at Winchester House, Old Broad-street, the Marquis of Tweeddale, presiding, in the absence, through indisposition, of Viscount Monck.

In moving the adoption of the report, the **Chairman** expressed satisfaction at the decrease of £1,100 in the working expenses. The repairs of cables had cost £5,981, as against £9,858 in the corresponding period of the previous year. That was accounted for by the fact that the expenses of the "Minia" had been charged to renewal fund, for the reason that the ship had been employed in renewing a very considerable portion of cable that had been destroyed. That had cost £15,485. The repair was in connection with the Brest-St. Pierre cable, which had been found broken in three different places, one break being at a depth of no less than 2,000 fathoms, the second at 400 fathoms (and both of those breaks had been repaired), and the third at 900 fathoms. They had every reason to believe that news would reach them in a few days of the successful repair of that break also. These repairs had been costly, but fortunately they a fund to draw upon to pay for them. The renewal fund now amounted to the handsome sum of £909,694, but the securities in which that fund was invested would yield now about £50,000 in excess of their cost price. He regretted that there had been a reduction of £19,635 in their receipts, owing to the Commercial Company lowering their rate from 1s. to 6d., the same tariff as the Company was charging. The 6d. rate had been adopted in the hope and belief that it would prove a remunerative tariff, but the experiment had now extended over two years, and in common with all the Atlantic telegraph companies they had come to the conclusion that the 6d. tariff was not only not remunerative, but that it would not become so within any reasonable time. For the first year the results obtained with that tariff were very satisfactory, the increase in the traffic amounting to about 140 per cent., and if that increase had gone on they probably would not have had to alter the rate. The increase, however, ceased about a year ago, and therefore they knew pretty well the effect of the 6d. tariff upon their finances. Negotiations were now pending for raising the rate to 1s., and there was a reasonable prospect of their being concluded in a satisfactory manner, and within a very

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short time. If, as they believed, the adoption of a shilling tariff would not lead to any serious reduction in the number of messages, the revenue would benefit very considerably, and he need hardly add that they hoped for a better dividend than it had been their duty to propose on that occasion. Their lawsuit with the French company had been gained by the Company, and large damages had accrued to them in consequence. No credit, however, had been taken in the accounts for any portion of those damages. He might add that claims had been made by the French company, which had somewhat delayed the negotiations to which he had referred.

Sir James Anderson seconded the motion.

The **Chairman,** in reply to questions, said that many people of great knowledge on the subject had fully believed that within a reasonable time the 6d. tariff would pay, on the same principle that lower rates had led to large increases of business in railway, omnibus, and other companies, not to speak of the great success which had attended the Post Office reductions of rates. One advantage of the low tariff had been that they had kept off competition. If they raised the rate beyond 1s., he was not sure that some competing schemes might not crop up in the future. The Directors had no intention of writing down the capital.

The motion was carried unanimously.

A discussion followed on a motion proposed by **Mr. T. Smith,** and seconded by **Mr. John Newton,** expressing the opinion of the meeting that it was desirable that from the 1st inst. the whole of the interest arising from the investments of the renewal fund should be carried to revenue account.

Mr. Gueedon protested against any interference with the renewal fund, and moved an amendment to the effect that the disposal of the interest on the investments forming the fund should be left to the discretion of the Directors.

Eventually, on a show of hands being taken, the **Chairman** declared the amendment carried.

SUBMARINE TELEGRAPH COMPANY.

The half-yearly ordinary general meeting of the proprietors of this Company took place at the Company's offices, Throgmorton avenue, London-wall, on Tuesday. Sir Julian Goldsmid, Bart., presided, and there was a large attendance of shareholders.

The Directors' report for the half-year, ending 30th June last, stated that the joint earnings of the two companies amounted to £67,397, and the working expenses to £27,788. The joint earnings were £2,663 more, and the working expenses £521 less than the corresponding period of 1887. The result of the business for the half year enabled the Directors to add, as usual, 15 per cent. of this Company's proportion of the receipts to the reserve fund, to recommend a dividend at the rate of 13½ per cent. per annum, and to carry a balance of £261 to next account. The number of messages transmitted in the six months was 1,717,311, containing 19,073,919 words, against 1,618,634 messages in 1887, containing 17,901,009 words. All the Company's cables, as well as those worked by the Company, were in good working order. The Company's steamer, "Lady Carmichael," had been thoroughly overhauled in the course of the half-year, at a cost of £907, of which £500 had been charged in the annexed accounts, and the balance would be charged against the revenue of the next half-year. The steamer was now in excellent condition, both as to her hull and general machinery, and had been surveyed by Lloyd's surveyors, who had classified her as a vessel of the first class. The negotiations between her Majesty's Government and the Board, referred to in the last report, had been continued during the half year, and were now on the point of completion. As soon as an agreement had been finally arrived at the Directors would forthwith lay it before the proprietors for their approval.

The **Chairman,** in proposing the adoption of the report, together with the statement of accounts, said the observations he had to make that day were very short indeed, and very simple. They would see that there had been a fair increase in the traffic during the six months which was under review. The number of messages and words transmitted over the Company's service were given in the report, but the average length of the messages was not, and he dare say that it was of interest to many people. The average length of messages during the last half-year was 11·06 words, and during the half-year then under review it was 11·11, showing a very slight improvement in the length of the messages. In former years he had told them, when there was a complaint of the diminution of the number of words in the messages, that he thought they must come to a termination of that reduction before long, and when he had been asked to fix the figure at which it would terminate he had said that he could not imagine that it would go below 11·0. It had, however, gone slightly below 11·0 on one or two occasions, but he thought that was the average. With regard to the concession, they all knew that it would terminate very shortly. He had mentioned on previous occasions that not so very long ago they had great hopes that the concession given them by the French Government would be renewed, and had it not been that a very strong opinion had been entertained by the English Government he believed that would have been the case, but, like sensible men, a decision having been come to, the Directors had thought it was in the interests of the shareholders of the Company to make the best of it. Ever since, therefore, they had been in active communication with the English and French Governments upon the subject of taking over the property of the Company at the termination of the concession. On the last occasion Mr. H. Brand, who then presided, told them that the negotiations were progressing, and although they had come to an arrangement with regard to several points raised, there were still some which depended partly on the English Government, and partly on the French Government, which had still to be settled. Consequently, he was not in a position to day to state the absolute result of their negotiations. The shareholders had always reposed the greatest confidence in the Board, and he assured them that he and his co-directors were doing their very best in the interests of the Company. It would be gratifying to them to know that they had maintained their cables and ships, and, in fact, all the property connected with their business, in the very best possible condition, and he believed there was no telegraph company in the world that had a better plant or machinery than they had. He concluded by formally moving the adoption of the report.

The **Hon. Ashley Ponsonby** seconded the motion.

In the course of a brief discussion which followed, **Mr. Soden** urged the importance of shareholders in other submarine telegraph companies to protect their interests in case the Government should step in and claim their right to the foreshore.

The **Chairman,** in reply, assured the hon. proprietor that the interests of the shareholders would be protected. It was not only the English Government with whom they had to deal, but the French and also one or two others. If they had not attained the success they desired it was not owing to any fault or neglect of the Board, but due to circumstances over which they had no control.

The motion for the adoption of the report was then unanimously agreed to.

The retiring Directors, the Hon. Ashley Ponsonby and the Hon. H. Brand, and the Auditors having been duly elected, a cordial vote of thanks was passed to the Chairman and Directors, and the meeting terminated.

GLOBE TELEGRAPH AND TRUST COMPANY.

The 15th ordinary general meeting of the Globe Telegraph and Trust Company, Limited, was held on Friday at Winchester House, Old Broad-street, Sir J. Pender presiding.

In moving the adoption of the report, the **Chairman** observed that on the present occasion their prospects were brighter than when he last addressed them. The Eastern and Eastern Extension Telegraph Companies had in a great measure recovered what they had been obliged to sacrifice at the Berlin Telegraph Conference, and there was now a prospect of seeing increased rates charged by the Atlantic cable companies. He might also state that the prospects of their other investments were all encouraging. They now proposed a dividend on the ordinary shares which would make the total distribution on those shares for the past year £3. 10s. per cent., against £2. 7s. 6d. per cent. for the previous year; and he found that from the beginning they had always paid their preference dividend of 6 per cent., while the average dividend on the ordinary shares had been 4·48 per cent. On the combined shares, the average dividend paid by the Company from the beginning had been £5. 2s. 4d. per cent. On about the 1st of September, he believed that the rate charged by the Atlantic cable companies would be raised to 1s., and if with that rate the present traffic of those companies was maintained, the Globe Company would be very beneficially affected. He expected they would be paid off, about the end of this year, for their holdings in the capital of the German Union Telegraph and Trust Company, and in the German Union Telegraph Company of Berlin, whose lines had been acquired by the Imperial German Government. He hoped they would not obtain, in the future, a smaller rate of interest on that particular portion of their capital.

The **Marquis of Tweeddale** seconded the motion.

In the course of a short discussion complaint was made by **Mr. Weatherby** of the expenses.

The **Chairman** said that the capital of the Company was over £3,000,000, and the percentage of expenses for the conduct of such a company was considerably below the average of similar companies in London. Mr. Newton was wrong in supposing that the difficulty of carrying out the proposal for which the Company was originally formed had been caused by the jealousy among the directors of the telegraph companies. As a matter of fact, it was the absence of jealousy among them which had made the submarine telegraph system what it was.

The motion was then adopted, and the retiring Directors and Auditors were re-elected.

SOUTH-EASTERN (BRUSH) ELECTRIC LIGHT AND POWER COMPANY.

An extraordinary general meeting of the South-Eastern (Brush) Electric Light and Power Company, Limited, was held on the 30th ult. at the Guildhall Tavern, Gresham-street, Mr. W. H. Pannell, F.C.A., the liquidator, in the chair, to consider resolutions—(1) for adopting the accounts and report presented by the liquidator (audited and approved by four of the principal shareholders) as to the manner in which the winding-up had been conducted and the property of the Company disposed of, and authorising the liquidator to distribute the balance of cash in hand as proposed in the accounts; (2) authorising the liquidator to destroy all books and papers of the Company and of, or relating to, the liquidation at the expiration of three months; and (3) "That the liquidator do forthwith, in accordance with section 143 of the Companies Act, 1862, report to the Registrar of Joint Stock Companies that the affairs of this Company are fully wound up, and that the final meeting has been held." When the Company went into liquidation there was 6s. 6d. a share uncalled, and the liquidation had been closed with a call of 2s. 3d. a share. It was proposed to distribute 8s. 7d. a share on the 400 fully-paid shares, and ½d. a share on the 17,654 ordinary shares. The total loss of the Company had been £45,953.

The **Liquidator** formally proposed the resolutions *seriatim*.

Mr. Booker moved an amendment to the effect that the books should not be destroyed for a year, in order that the shareholders might have further opportunity afforded them for prosecuting the promoters, directors, and others.

The amendment was not seconded, and the resolutions were agreed to.

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PROVINCIAL BRUSH ELECTRIC LIGHT AND POWER COMPANY.

An extraordinary general meeting of the Provincial Brush Electric Light and Power Company, Limited, was held afterwards, **Mr. Pannell** in the chair, to consider precisely similar resolutions. On the Company going into liquidation there was an uncalled liability of 5s. a share, and the liquidator had managed to close affairs with a call of 2s. 6d. a share. The balance available for distribution by way of dividend, as return of capital, to the shareholders at the rate of 3 1-3d per share, was £248. 19s. 9d. The total loss of capital had been £51,096.

The resolution having been proposed, **Mr. C. H. Stewart** expressed his sympathy with the observations which Mr. Booker had made at the previous meeting, but said he felt that the liquidator had done the best he could for the shareholders. He considered that the inception and management of the two companies had been a stain on the commercial morality of the City. With regard to the Consolidated Company, neither the South-Eastern nor the Provincial Company had had anything to do with it except that both of them had been drawn upon for its benefit.

The resolutions were passed.

NEW COMPANIES REGISTERED.

Crompton and Company, Limited.—Registered by Ashurst, Morris, Crisp and Co., 6, Old Jewry, E.C., with a capital of £140,000, in £5 shares. Object: to adopt and carry into effect an agreement dated July 16, 1888, and made between R. E. Crompton and Co. of the one part and Francis R. Reeves, on behalf of the company, of the other, for the acquisition by the Company of the business, goodwill, machinery, privileges and other property of Messrs. R. E. Crompton and Co.; to acquire any additional letters patent relating to inventions for the production or supply of heat, light or power by means of electricity, magnetism, or any other agent, or any inventions of a like character, and to take and work any license or business in connection with such inventions. The first subscribers are :—

	Shares.
The Right Hon. Viscount Torrington, Maidstone	1
C. Grant, K.C.S.I., 5, Hyde-park-place, W.	1
F. T. Metcalfe, 4, St. Mary-axe, E.C.	1
J. F. Albright, Savernake Lodge, Chelmsford	1
R. S. B. Crompton, 23, Porchester-gardens, W.	1
H. S. Price, 52, Queen Victoria-street, E.C.	1
E. T. Botwright, 23, Sutton-place, Hackney, E.	1

There shall not be less nor more than seven directors, and the first shall be appointed by the subscribers to the memorandum of association. The qualification of a director shall be the holding of at least £500 in the capital of the company. The remuneration of the directors is fixed at £1,000 per annum.

Metropolitan Electric Supply Company.—The Metropolitan Electric Supply Company, Limited, has been registered with a capital of £500,000, in 50,000 shares of £10 each, being 49,900 ordinary shares, and 100 fully-paid founders' shares, to be increased from time to time as the works extend. The Directors are :—

Sir John Pender, K.C.M.G., Chairman of the Eastern and Eastern Extension Telegraph Companies, Chairman.
Sir George Elliot, Bart., M.P., Director of the Telegraph Construction and Maintenance Company, Limited.
Sir Robert N. Fowler, Bart., M.P., Alderman (Messrs. Dimsdale, Fowler, Barnard and Co.)
Admiral Sir George H. Richards, K.C.B., F.R.S., Managing Director of the Telegraph Construction and Maintenance Company, Limited.
Sir James Anderson, Managing Director of the Eastern and the Eastern and South African Telegraph Companies, &c.
J. Spencer Balfour, Esq., Deputy-Chairman of the Debenture Corporation, Limited.
J. E. H. Gordon, Esq., Electrical Engineer.
J. C. Parkinson, Esq., Managing Director of the Alexandra (Newport and South Wales) Docks and Railway Company.
J. Denison Pender, Esq., Director of the Eastern Extension Telegraph Company, Limited.
John B. Verity, Esq. (Messrs. B. Verity and Sons, Electrical Engineers).
Henry Weaver, Esq., Managing Director of the Anglo-American Telegraph Company, Limited.
H. Granville Wright, Esq., Director of the Hotel Victoria, Limited.

Chelsea Electricity Supply Company.—The Chelsea Electricity Supply Company, Limited, with a capital of £100,500, divided into 20,000 shares of £5 each, and 500 founders' shares of £1 each, has been formed to establish a central station for the supply of electricity for lighting and other purposes in what is described as one of the most important residential districts of London. The Company was founded in November, 1884, in anticipation of alterations in the Electric Lighting Act of 1882, and £1,650 has been expended in securing the necessary parliamentary powers, the agreement for the lease of a suitable site for the central station, in canvassing the district, &c. The system of distribution which will be adopted by the company is one in the economy and efficiency of which the directors have, they state, the fullest confidence. The electricity generated at the central station will be generated by underground mains to sub-centres, where accumulators will be charged. From these storage stations the current will be distributed to the surrounding buildings. According to the prospectus, the Company has obtained information as to the demand for electric lighting in the area to be lighted, and 6,000 lights may be said to represent the immediate demand, with a good prospect that this will be increased within the same area. The present issue is 6,400 ordinary shares, of which 6,240 are now offered for subscription. The Directors are:—

The Rt. Hon. Lord Thurlow, F.R.S., Chairman of the Anglo-American Brush Electric Light Corporation, Limited.
J. Irving Courtenay, Esq., Managing Director of the Electrical Power Storage Company, Limited.
Nugent Daniell, Esq., 17, Lennox-gardens, S.W.
Sir George R. Prescott, Bart., Chairman of Callender's Bitumen Telegraph and Waterproof Company, Limited.
Major-General Webber, C.B. (R.E. retired), Past-President Society of Telegraph Engineers and Electricians.

Committee of Consultation.

T. O. Callender, Esq., Manager of Callender's Bitumen Telegraph and Waterproof Company, Limited.
Frank King, Esq., Superintending Engineer of the Electrical Power Storage Company, Limited.
J. S. Raworth, Esq., Superintending Engineer of the Anglo American Brush Electric Light Corporation, Limited.

"Woodite" Company, Limited.—Registered by Watson, Sons and Room, 12, Bouverie-street, E.C., with a capital of £50,000, in shares of £10 each. Object: to acquire from Mrs. Annie Matilda Wood all or any of certain patents granted in the years 1885, 1886, 1887 and 1888; also the two trade marks "Woodite" and "Whaleite," or any modification thereof, the registered design, models, drawings, stock, trade secrets and other things belonging to Mrs. A. M. Wood and connected with "Woodite," "Whaleite," or any of them; to acquire licenses and vend the same throughout the world. The first subscribers are :—

	Shares.
E. S. Inman, 13, Glazbury-road, West Kensington	1
J. Brunton, C.E., Westminster, S.W.	1
W. Wood, 13, Delahay-street, S.W.	1
S. Long, C.E., 13, Delahay-street, S.W.	1
W. Brown, 19, Campden-hill-road, Kensington	1
A. M. Wood, 13, Delahay-street, Westminster	1
T. H. Bartlett, Garratt-park, Wimbledon	1

The number of directors shall not be less than three nor more than nine, and the first shall be E. S. Inman, J. Brunton, Captain J. W. Clarke and W. Brown. Mrs. Annie Matilda Wood shall be appointed a director immediately after the first allotment of shares. The directors shall be paid £750 per annum, and £100 additional for every 1 per cent. of dividend over 10 per cent., but their remuneration shall not exceed £2,000 per annum.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ending July 27 amounted to £4,592.

National Telephone Company.—The report of the Directors of the National Telephone Company, Limited, for the year ended June 30 states that the gross revenue for the past year is £99,119, against £85,073 for the previous year, and the amount carried forward to next year is £58,495, against £49,525 carried forward last year. The annual rentals on June 30 reached £106,572, against £90,537 at the corresponding date of the previous year, showing an increase of £16,035. There is also a revenue derived from fee messages at the rate of £3,000 a year, against £1,800 last year, making the total gross revenue reached on June 30 £109,572, and giving an increase of £17,235 over the total of last year. After providing for the accrued interest on the debentures, the dividend of 6 per cent. on the first preference shares, the dividend of 6 per cent. on the amount of second preference capital paid up, and after having paid an interim dividend for the first half of the year at the rate of 4 per cent. per annum on the ordinary capital, there remains a balance of profit amounting to £17,003. Out of this the Directors propose to allot a further sum of £11,250 to the payment of a dividend upon the ordinary capital for the second half of the year, at the rate of 5 per cent. per annum, and besides placing £2,500 to the reserve fund to carry forward £3,253. Out of the amount carried forward a sum will be required towards the adjustment of long-standing claims between the United Telephone Company and this Company, now in process of being satisfactorily settled by mutual concession.

PROVISIONAL PATENTS, 1888.

JULY 20.

10,492. **Improvements in holders for incandescent electric lamps.** Charles Scott Snell, Culver Park, Saltash.

10,505. **Improvements in instantaneous make and break electric switches.** Emile Rousseau, 3, Knott's-green, Leyton, Essex.

10,524. **Improvements in electric railways.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Middlesex. (The Bentley-Knight Electric Railway Co., United States.)

JULY 21.

10,568. **Improvements in the manufacture of electric bells.** Frederick Henry Boyce, Blake-street, Hulme, Manchester.

10,572. **Controlling train lighting dynamos.** John Harold Woodward, Bernard Mervyn Drake, and John Marshall Gorham, 2, Princes Mansions, Westminster, London, S.W.

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10,584. **Improvements in and relating to switch boards or apparatus for connecting circuits and signalling in telephone exchange systems.** Francis Raymond Welles, 50, Bedford-row, London, W.C.

10,604. **Improvements in the elements for secondary batteries.** Illius Augustus Timmis, 2, Great George-street, Westminster, S.W.

JULY 23.

10,631. **Improvements in electrical night-signalling apparatus.** Emil Kaselowsky, 6, Bream's-buildings, London. (Complete specification.)

10,637. **Improvements in plates for accumulators.** George Havenith, 323, High Holborn, London, W.C.

10,654. **Improvements in electric arc lamps.** Walter Russell Mortimer and James Holloway, 28, Southampton-buildings, Chancery-lane, London, W.C.

JULY 24.

10,666. **Switchback telegraph.** Henry Ridley and John Skeldon, 125, Derby-street, Bolton.

10,690. **The automatic alternatable position flushing and draining in and out of action electric battery, and system for electric batteries.** Alfred Horace Gladwin, 18, Oval-road, Regent's Park, N.W.

10,691. **Improvements in or relating to electrical transmitting instruments.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.) (Complete specification.)

10,730. **Improvements in electric firing gear for guns.** Andrew Noble, Jesmonddene House, Newcastle-upon-Tyne.

JULY 25.

10,766. **An improvement connected with arc lamps whereby the controlling mechanism is simplified for the purpose of adjusting the distance of the carbons and to facilitate the steadiness of the arc.** John Kent, 9 and 10, Railway Approach, London Bridge, S.E.

JULY 26.

10,813. **Improvements in and relating to apparatus for receiving payment and administering electricity for medical or other purposes.** William John Woodward, of Judson's and Co. (Limited), 45, Southampton-buildings, London.

COMPLETE SPECIFICATIONS ACCEPTED.

JULY 21, 1887.

10,200. **Improvements in dynamo-electric generators and motors.** H. C. Bull and Co. (Limited), and Henry Clay Bull, 8, Quality-court, Chancery-lane, London, W.C.

SEPTEMBER 2, 1887.

11,938. **Improvements in or connected with clocks and apparatus for winding the same by electricity.** James Grieve Lorrain, Norfolk House, Victoria Embankment, London, W.C.

SEPTEMBER 21, 1887.

12,823. **Improvements in telephonic arrangements or systems especially adapted for intercommunication in houses, offices, and the like.** Alan Archibald Campbell-Swinton, 47, Lincoln's-inn-fields, London.

SEPTEMBER 29, 1887.

13,207. **Improvements in indicators for electric bells.** Arthur Morley and Hubert Wilberforce Wilson, 77, Chancery-lane, London, W.C.

13,221. **Improved means or apparatus for controlling in an automatic manner reciprocatory, vibratory, or oscillatory movements of armatures and other electrical apparatus.** John Henry Holmes, 46, Lincoln's-inn-fields, London, W.C.

OCTOBER 1.

13,333. **Improvements in secondary generators, transformers, or converters of electricity.** John Dixon Gibbs and Emile Fesquet, 47, Lincoln's-inn-fields, London.

OCTOBER 3.

13,338. **Improvements in electric lamp attachments.** Wilson Hartnell, 9, Beckett's Bank Chambers, Leeds, Yorkshire.

MARCH 28, 1888.

4759. **Improvements in and relating to telephonic apparatus.** Henry Harris Lake, 45, Southampton-buildings, London. (International Dudley Signal Co., United States.)

JUNE 26, 1888.

9332. **Improvements in electrical connection of railroad rails.** Frederick Stitzel and Charles Weinedel, 18, Buckingham-street, Strand, London, Middlesex.

SPECIFICATIONS PUBLISHED.

1877.

1996. **Electric light.** P. Jablochkoff. (Fourth edition.) 8d.

1878.

2003. **Application of electricity.** H. J. Haddan. (Brush.) (Fifth edition.) 1s. 3d.

1882.

4810. **Dynamo-electric machines.** R. E. B. Crompton and G. Kapp. (Third edition.) 6d.

1887.

9264. **Electric clocks.** J. G. Lorrain. 8d.

10,199. **Electric metallurgical processes, &c.** H. C. Bull and Co. and H. C. Bull. 11d.

10,555. **Electrical batteries.** C. P. Elieson. 8d.

11,091. **Friction couplings governed by electricity.** J. S. Raworth and H. M. Sayers. 8d.

11,704. **Electrical insulators.** W. E. Langdon and others. 8d.

11,718. **Electrostatic generators.** H. Glaser. 8d.

11,776. **Synchronising electric telegraph instruments.** W. H. Beck. (Cassagnes.) 11d.

14,270. **Producing sheet copper by electro deposition.** B. J. B. Mills. (Emerson.) 8d.

1888.

5831. **Electric batteries.** T. Schonherr-Schoner. 8d.

6191. **Preparing carbons for electric arc lighting.** C. A. J. H. Schroeder. 4d.

7851. **Switches for electric circuits.** W. P. Thompson. (Westinghouse.) 8d.

7853. **Storage batteries.** W. P. Thompson. (Gibson.) 8d.

COMPANIES' STOCK AND SHARE LIST.

Last Dividend		Name.	Paid.	Price. Wednesday.	Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	Africal Direct 4%	100	102	1 Mar.	5%	Gt. Northern 5% Deb., '83.	100	108
12 Feb.	1/2	Anglo-American Brush E.L.	4	2⅜	29 Feb.	10/0	India Rubber, G. P. & Tel.	10	17½
12 Feb.	2/0	— fully paid	5	3½	11 May	37/6	Indo-European	25	38
26 April	1%	Anglo-American	100	41⅛	30 May	3/0	London Platino-Brazilian...	10	6½
26 April	2%	— Pref.	100	69	16 Mar.	5%	Maxim Weston	1	⅛
12 Feb., 85...	5/0	— Def.	100	14½	30 May	2½%	Oriental Telephone	11	⅜
28 June	3/0	Brazilian Submarine.....	10	12⅜	26 April	4/0	Reuter's	8	8
14 June	1/0	Con Telephone & Main ...	1	⅜x	.....	...	Swan United	3½	2⅜
15 Feb.	8/0	Cuba	10	13⅜	15 Feb.	15½%	Submarine	100	150
28 July	10/0	— 10% Pref.	10	18¾	15 Oct.	6%	Submarine Cable Trust ...	100	97
28 Mar.	2/2½	Direct Spanish	9	4	29 Feb.	36/0	Telegraph Construction ...	12	39½
28 Mar.	5/0	— 10% Pref.	10	10	3 Jan.	6/0	— 6%, 1889	100	105
28 Mar.	2/0	Direct United States	20	9⅛	12 July	10/0	United Telephone	5	13½
12 April	2/6	Eastern	10	12½x	.....	...	West African	10	5¼
12 April	3/0	— 6% Pref.	10	15¼	1 Mar.	5%	— 5% Debs.	100	95
1 Feb.	5%	— 5%, 1899	100	111	12 July	4/0	West Coast of America ...	10	6¼
26 April	4%	— 4% Deb. Stock	100	106½	30 June	8%	— 8% Debs.	100	117
12 July	2/6	Eastern Extension, Australasia & China.....	10	13⅛	11 May	9/	Western and Brazilian.....	15	11⅛
1 Feb.	6%	— 6% Deb., 1891	100	104	11 May	6/10½	— Preferred	7½	6 13/16
2 July	5%	— 5% Deb., 1900	100	104	11 May	2/1½	— Deferred.....	7½	4 5/16
2 May	5%	— — 1890	100	102	1 Feb.	6%	— 6% A	100	113
2 July	5%	Eastern & S. African, 1900	100	102	1 Feb.	6%	— 6% B	100	108
28 Mar.	8/3	German Union	10	9½	.....	...	West India and Panama ...	10	1 1/16
12 April	2/0	Globe Telegraph Trust.....	10	6⅞	30 May	10/0	— 6% 1st Pref.	10	11½
12 April	3/0	— 6% Pref.	10	14¼	13 May, '80...	...	— 6% 2nd Pref.	10	7⅜
30 April	5/0	Great Northern.....	10	14¼	2 May	7%	West Union of U.S.....	$1,000	123
					1 Mar.	6%	— 6% Sterling	100	104

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NOTES.

Chicago.—The central portion of Chicago is to be lighted by arc lights, run by the city's own plant. It will take 500 h.p., and will be ready in a month.

Personal.—Mr. J. Wright, late secretary of the Maxim-Weston Company, has, we understand, taken the position of manager to the Schanschieff Battery Syndicate.

Bilbao.—The Spanish Government is going to spend a million sterling in improving the port of Bilbao. Some electric lighting plant ought to be wanted for this.

Telephone Calls.—Kansas City exchange is said to have the largest amount of business of any telephone exchange. Its average of calls is 12 for each subscriber per day.

Electric Tramways in Australia.—It is stated that the tramway company of Brisbane is making arrangements to substitute electric motors for the present horse-power cars.

Tenders Wanted.—We understand that tenders are invited for the wiring and fitting up of Messrs. Hampton and Sons' premises, in Pall-Mall East, Whitcomb-street, and Monmouth-court.

Scotch Incandescent Lamps.—The manufacture of a new incandescent lamp of large candle-power has been commenced at Woodside Electric Works, Glasgow by Mr. Rankin Kennedy.

Motor Patents in America.—After ten years' litigation, priority has been given to Mr. Stephen D. Field for the modern type of dynamo electric motor. This decision may have very important consequences in the States.

Brick-making by Electricity.—A 20 h.p. and a 30 h.p. Sprague motor have just been sent to Nebraska to be used in operating machinery for making brick. This is the first application of this nature so far made with such large motors.

"Wild" Electricity.—A new definition of high tension electricity comes to us from Canada, where the telephone electricians talk of the currents used on arc light circuits as "wild" electricity; and that used for incandescent circuits, of course, is "tame" electricity.

Cox-Walker Swinton Magneto Bells.—With reference to the description of this apparatus in last week's issue, we are informed that the Equitable Telephone Association, Limited, of 75, Queen Victoria-street, E.C., have been appointed sole agents for the sale of these instruments.

Alternate Currents.—Banker Moritz Mayer, of Vienna, has his town house lighted with electric light, for which purpose he has a set of 30 accumulators. In the summer he takes these out and fits them into an electric launch, by means of which he careers about the beautiful waters of the Wörthersee. Not a bad idea.

Pacinotti Armatures.—Mr. Esson informs us that the advantage derived from Pacinotti *v.* Gramme armatures is resolved into a question of *copper v. machining*, not copper *v.* machinery, as printed in our issue of last week. In the same letter he mentions that the method of securing the armature core described by Mr. Walker has been given up in the Phœnix machines for some time.

Lightning Conductors at the British Association.—The Organising Committees of Sections A and G of the British Association have arranged a joint discussion on "Lightning Conductors," to be held at the Bath Meeting in September. Mr. W. H. Preece, F.R.S., will open the discussion, and Prof. Oliver J. Lodge, F.R.S., will defend the position he took up this year before the Society of Arts.

Folkestone.—Folkestone still seems to be *in statu quo* as to the electric light, although agitated in the desire to have the new illuminant. At the meeting last week Alderman Dunk seemed to fear that a committee would be appointed, which would make what contracts it pleased, and spend what money it liked. The Town Clerk said in any case the agreement would be a provisional one, and that nothing could be done unless the Town Council did it. It was mentioned that the utmost they could go to was to the limit of a shilling lighting rate.

"Journal" of the Society.—The new number of the *Journal* of the Society of Telegraph-Engineers and Electricians has been issued, containing the paper on "Fire Risks," by Mr. Preece, and Mr. Crompton's reply to the discussion on his paper on "Central Station Lighting." Sir William Thomson's paper on "New Standard Measuring Instruments" is also given, with illustrations. Prof. Silvanus Thompson's able and interesting historical paper on "The Influence Machine, from 1788 to 1888," is given in full, with illustrations of the various type of influence machines from John Canton to Wimshurst.

Electric Signals for the Army.—The introduction of Bruce's balloon-signalling apparatus has apparently given the idea that similar signals can be transmitted by hand while on the ground with advantage by army scouts or signal officers. Six small incandescent lamps are carried in the knapsack, with bulbs of different colours. A battery is also carried in the knapsacks, together with a very small electromotor, by means of which the tiny lamps can be elevated high in the air. The current can then be turned on, and by use of the various colours signals can be transmitted, and conversation can be carried on at night over long distances.

Medical Electricity.—Greater and greater attention is being paid to the use of electricity in medicine. Mr. W. Lynd, M.S.T.E., who has lately removed to Faraday House, Richmond Hill, Bournemouth, has performed successfully the process of removing fibroid tumours electrically. A paper has lately appeared in the *Lancet* on the use of electricity, by W. S. Playfair, M.D., F.R.C.P., Professor of Obstetrics at King's College, strongly advocating its more extended use. The growth of medical opinion in this direction is remarkable. We recollect hearing Dr. Royston-Piggott, F.R.S., a very well-known physician in his day, now better known for his valuable contributions on microscopy and astronomy, having said that he ran great danger of being plucked in his examination for his known belief in the virtues of electricity, and was advised to drop it for a year if he wished to pass. It is still his belief that this offers the most promising field for young medical practitioners. Several papers embodying this subject are to be read at the Glasgow meeting of the British Medical Society to be held this month.

Telephones on Trains.—Sir Edward Watkin, it is said, intends offering a prize of 100 guineas for the best solution of the problem of telephoning on trains between passenger and driver, or between passenger and guard. He

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has been trying for some years to do this, and believes it to be the true solution of the problem of proper communication. "Of course," Sir Edward is reported as saying in a special interview with the *Pall-Mall*, "there are many difficulties—vibration and so on; but in my judgment there is nothing that cannot be overcome. If it could be done, that would be a revolution. When an old woman feels she can talk to the guard and her conversation will be registered by the telephone company—we should have to carry telephone boys on the engine or in the van—she feels it a comfort; she is no longer, as she fancies, between a certain person and the deep sea. At present, of course, it would not do to stop a train because a man thinks the carriage is shaky when it is perhaps only his nerves. With a telephone he could talk away, and properly explain whatever he wished. That is one of my pet projects, and another is the electric locomotive."

Long-Distance Telephoning. — There are signs already that the long-distance telephone will eventually cut out its older rival—at least, in many fields. A contest was lately arranged in New York for a ten minutes' reporting trial between telegraph (with transcriber of the notes) and telephone (with type-writing direct), and the telephone came off a very good second indeed, not much difference being between them, and a further trial was to come off. Long-distance telephoning has passed beyond the experimental stage, and has become an assured success. The long distance line is now complete between Paris and Marseilles, and a long-distance line is being built from New York to Chicago. One proof of the usefulness of the system is shown by the fact that the only communication between New York and Boston during last winter's storm was by a long-distance telephone. A net-work of telephones is being gradually extended over England; Glasgow is connected with most of the neighbouring towns, and it is intended to connect London with Bath and the West of England in this manner through Swindon. Verily, we shall soon be able to talk and write direct to the ends of the earth.

Cheap Electricity.—If the statements reported as having been given by a Swedish gentleman, Jonas Venstrom, of Orebro, are accurate, the useful service of electricity is extraordinarily cheap in Sweden. The following is what is said to be the state of affairs in Orebro, a town of some 40,000 inhabitants. The annual charge for a telephone is 17s., and for this charge the subscriber has a range of 100 miles from his home. In the city of Stockholm there are 7,000 subscribers, and every subscriber has his own instrument. The telephones there in use are made by the Erickson Company, of Stockholm, and are said to act much better than those in use here. At any rate, Mr. Jonas Venstrom says they can send a message with greater clearness a hundred miles in Sweden than we can from the suburbs of our towns. Electric lights are quite common, and the charge for an arc lamp is only about twenty-five shillings a year. Someone has said that the English invent and the Americans use the inventions. It seems from this that the Americans and English invent and the Swedish use them. However much we may long for the time, it will not be just at present that we shall be able to obtain a telephone and an arc light for a couple of guineas a year. This is where patent rights come in.

Atlantic Cable Tariffs.—At last the Commercial Cable Company has obtained a well-earned triumph, and from September 1st the tariff per word across the Atlantic is to be one shilling. Of the tactics of the combined companies the less said the better, but the facts may be recorded. When the Mackay-Bennett combination laid its cable, efforts were made to induce them to join the pool. So far as we can gather, these efforts at an agreement failed because there was no reality in them. The pool then put on the screw, saying agree to our terms or we will fight. They fought. The sixpenny tariff was a "fighting tariff." It was spoken of as such, boasted about as such. Result: no dividends to the shareholders and no "prostration in fear" from the Commercial cable. The fighting tariff failed, and then it was dubbed euphonistically as an experimental tariff, one that was fairly and squarely tried as an experiment to see if the increased messages would recoup the loss from tariff. In other words, being worsted in the fight, a happy thought suggests the calling it "failing in experiment," and now the terms long since suggested by the Commercial have been adopted. The telegraphing public were the gainers during the period of the "experiment," and now we trust to see a permanent settlement of the squabbles and a greater attention to the development of real business.

The Maxim-Weston Company.—The longest lane has its turning, and no doubt the resignation of Mr. Hugh Watt, M.P., will be a turning-point for better or worse to this company. The late chairman, according to his own ideas, took up the company when it was *in extremis*, and has carried it on, more or less successfully, with or without co-directors till quite recently, when the hubbub of revolt among the shareholders became too great for Mr. Hugh Watt to withstand. Years ago the present writer had several long conversations with Mr. Maxim and Mr. Massey, and heard their views upon the management of the company, and since then he has watched with some care the progress of the Maxim-Weston Company. It may surprise many to know that Mr. Maxim came over to England under an agreement with the company, which agreement was broken, or, at any rate, not carried out, and so, instead of this inventor's talents being at the service of the company, they were rejected. Unable, under the terms of the agreement, to turn his attention to electrical matters, Mr. Maxim turned his attention to military guns, with the result of designing the well-known Maxim gun. We ask, in all seriousness, What has the Maxim Company lost by such a course of action—by the driving away out of the work of the company one of the ablest inventors of the age?

Bean-Feast.—On Saturday last the employés of Messrs. Immisch and Co., electrical engineers, of Kentish Town, celebrated their sixth annual summer excursion. The party, to the number of about 85, left London in three four-horse brakes about eight o'clock, and after a pleasant ride arrived at Rickmansworth about 11.30. The head-quarters were The Swan Hotel, and after partaking of refreshments, they adjourned to a meadow for the purpose of indulging in a friendly game of cricket between the married and single members of the firm. After a most pleasant and closely-contested game, the singles, under Mr. Price, were accorded the victors over the married, who were led by Mr. C. F. Quicke, by 15 runs. The hour for dinner having arrived, all did ample justice to the excellent viands placed before them by the worthy host (Mr. W. Large). After dinner the usual toasts were proposed, among them being "Health, wealth, and prosperity to the firm of Messrs. Immisch and Company!" which was drunk with three times three and musical honours, the chairman (Mr. C. F. Quicke, manager to Messrs. Immisch)

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remarking that the way in which they had drunk the health of the firm showed the unanimity which existed between employer and employed. A pleasant stroll was followed by tea, with toast and song, and the party returned about eight o'clock, having spent a most enjoyable day.

Cost of Electric Traction.—It has been aptly pointed out that if the tramway companies could see but a clear saving of one farthing per car mile only on their present cost of about 5d. per car mile, it would be worth their while to operate by electricity, for that saving would represent an increased dividend of two per cent. What, then, is to be said of the cost of the Richmond Electric Railway, a description of which we are giving in our columns? The entire operating expenses chargeable at the central station for twenty cars, with the present mileage, on the heaviest section of the track, is only two cents—that is, one penny—per car mile. This includes electrician, engineers, firemen, dynamo men, all coal, oil, waste, water, lighting and depreciation; the working force being, with the exception of one man, sufficient to handle forty cars instead of the present twenty. When the forty cars are in operation the expense will be reduced to about 1½ cents—that is, three farthings—per car mile run. Of course these figures are American, and may not be exactly paralleled in England, much more in London, where many incidental expenses are very heavy. But the item is suggestive enough to allow a considerable margin for such incidentals, and yet to show a very great increase of profit. We shall be expecting, after consideration of the concrete and practical instance now before us, that English financiers and tramway managers will begin to appreciate the capabilities of the electro-motor.

Bath.—The following editorial remarks in last week's *Cheltenham Examiner* will be read with interest:—"Bath has taken precedence of Cheltenham in the adoption of electricity for street-lighting purposes. At a meeting of its Town Council it was determined, by a majority of nearly two to one—22 to 12—to accept the tender of Mr. H. G. Massingham for the lighting of a large area of the city, and including its central and principal streets, for a period of seven years. The conclusion thus arrived at has not been reached without much and animated controversy, and it marks the triumph of intelligent enterprise over almost every form of obstacle that interested opposition could devise. The exact system of electric lighting adopted is of minor importance compared with the general effect of the decisive step taken. . . . The members of the Electric Lighting Committee of the Cheltenham Corporation recently had an opportunity of inspecting the installation at Taunton, under Mr. Massingham's personal direction, and the adoption of the same system at Bath endorses the favourable opinion our representatives formed of it. In some points of detail the installation at Bath will doubtless be an advance upon that at Taunton; but, in any case, the fact that a city of the importance and position of Bath has declared for the new illuminant is likely to exercise a marked influence upon the development of electric lighting in the provinces. Even Cheltenham may not be afraid to follow a lead that Bath has so spiritedly taken."

Electric Lighting in Scotland.—Mr. Rankin Kennedy, of Woodside Electrical Works, Glasgow, has recently completed installations of electric light on the following steamers:—The "Smith" and "Cass," two passenger ships, built by Messrs. R. and W. Hawthorn, Leslie and Co., Limited, for the Formosa Trading Co., China; the s.s. "Tynesider," owned by the Tyne Steam Shipping Co., and trading between Newcastle and London; the "Paula" and "Caucase," two oil-carrying steamers, built by Sir W. G. Armstrong, Mitchell and Co., Limited, Walker Shipyard; the "Trieste C," a small passenger steamer for the Adriatic, built by Messrs. Wm. Simons and Co., Renfrew; and the "Leon y Castilio" and "Vera y Glavojo," two steamers built by Messrs. D. J. Dunlop and Co., Port Glasgow, for the Canary Islands passenger and goods' trade. In addition to the above, the firm have now on hand three steamers, the "City of Oxford," "City of Cambridge," and "City of Calcutta," for the "City" Line of Messrs. G. Smith and Sons, Glasgow; two large oil-carrying steamers for Sir W. G. Armstrong, Mitchell and Co., Limited, and a number of other shipping and land installations of considerable importance. Mr. Kennedy has now completed, and is using exclusively for ship lighting, his double-cylinder single-acting engine. It is being very favourably received, and, we understand, is giving universal satisfaction; where direct driving is desirable, it is specially applicable. We hope shortly to publish a full description and results of tests of this engine.

Converts to Electric Tramways.—It will be noticed that we give continually, week after week, notices of the spread of electrical traction for tramways in America. It is impossible to follow the evolution of electrical traction in England without taking into account the great developments perceived in this department in the States, and persons in authority discussing the relative advantages and objections to the new system should realise that the phase they are passing through has been passed through in America, and that they cannot do better than learn from that experience. In America, twenty-eight cities have adopted the electro-motor for their streets, and over fifty more are investigating its merits with a view of adoption. The American technical press are just now jubilant over the conversion of Mr. Henry M. Whitney, of the West End Railway Company of Boston, to the merits of electric traction. Mr. Whitney's company were intending to put in a cable system; but, after examination of the Richmond electric road and that at Alleghany city, and after seeing with his own eyes what electricity can do, he is a thorough convert to the new system. "I believe," said Mr. Whitney before a Special Commission of the Brookline Board, "that the electric motor at this day has reached that stage of development which makes it a perfectly practicable working machine, superior in all respects to horses for quick transportation," and he goes on to point out its advantages also over the cable. "Such evidence as this from the outside," adds the *Electrical World*, referring to this speech, "is not to be gainsaid. It is simply the recognition by a leader in the world of finance and commerce of the claims that have been made by electricians, and every month will give it greater weight and validity."

Armature Protectors.—A special cut-out for the protection of armatures of dynamos is being introduced by Mr. Charles D. Wright, of Petersburg, Illinois. It is designed to throw a suitable amount of resistance into the circuit when the current therein becomes abnormal, and before the regulating devices connected with the dynamo can act, to protect the armature of the machine from being burnt out. Says Mr. G. E. Fish, electrician to the Chicago Arc Light and Power Company, with reference to this invention: "I have had a good deal of experience in connection with the practical operation of electric

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light stations, and consequently know the liability of even the best and most thoroughly insulated machines to occasionally burn out their armatures. I have therefore taken a good deal of interest in the protector, and in giving it a protracted and thorough test. I have now had the instrument up and in position three weeks, and have watched it closely during that time. I have frequently short-circuited the entire number of lights on the machine, thus putting the protector to its fullest test. As everybody at all familiar with the operation of electric light machinery knows, the short-circuiting of a machine in this manner would mean sure destruction of the armature without the protector. With the test I made, however, using the protector, the short-circuiting had no effect whatever on the running of the machine. The machine ran right straight along without the slightest disturbance, thus proving conclusively that the protector does just what is claimed for it—namely, absolutely protects the armature from injury when the machine from any cause becomes short-circuited. I cannot too highly endorse the armature protector, and I certainly think, and would recommend, that every dynamo in use should be protected by it."

Founders' Shares.—We have repeatedly pointed out, says the *Citizen*, what has been rarely noticed elsewhere, that companies started with founders' shares are intended to pay promotion money to an enormous amount. The holders of £1,000 of the capital of the Metropolitan Electric Supply Company are to take one-half of the profit earned by the remaining £499,000 beyond 7 per cent. If the company earns 10 per cent. per annum, its shareholders will have to pay away £7,500 a year to its promoters or their representatives, whose utmost outlay for preliminary expenses or risk of any kind in the adventure may not have exceeded £10,000. To make the arrangement at all a fair one for the other shareholders, the founders' shares ought to be cancelled when they have received altogether a fixed sum —such as, let us say, twice or three times the amount paid for preliminary expenses. If these had been the terms upon which the Metropolitan Electric Supply Company had offered its capital for subscription, it would have seemed a promising speculation. As it is, although it has already been, and doubtless will continue to be, vigorously written up, and its shares will doubtless for a time command a substantial premium, the cautious investor who has not been in a hurry to apply for them will bear in mind that many other opportunities to take shares in electric supply companies will probably occur. There will be no such monopoly in the future for electric lighting as there has been in the past for gas, and the quotation of the prices of gas companies' shares which the prospectus gives has really not much bearing upon the question of probable dividends for the shareholders of the Metropolitan Electric Supply Company. It has also yet to be proved that electricity can be supplied "at rates which will attract customers, and be remunerative to the company." So far, electric lighting has been a luxury for those who can afford to pay at least twice as much as for gas.

Restrictions of Telephones in England.—Some surprise has been expressed from time to time at the small amount of general use of the telephone service in London as compared with some other countries. Two points militate against its more extended use in London. One of these is the high charge for rent of the telephone, the usual price of twenty pounds a year being quite prohibitive for the common use of the middle class residence, such as is common in some towns in the States, where the lady of the house uses the telephone for all and sundry messages. She makes her morning calls by its means, orders her groceries and other necessaries, and embarks on a long chat with her dress-maker. She is in communication with her husband, her doctor, the police, and the fire-office. This extended use of the telephone will not come about until the usual charge is much reduced, say, to two or three guineas a year. It is possible that with co-operation of several of the inhabitants of the same place combined with pecuniary allowance from shopkeepers to those customers using the telephone (in return to saving of messengers), that a reduced rate might become more general in the suburbs of London without a reduction from the telephone companies. This has been done, we know, in a few cases, and the method is worthy of imitation. One enterprising shopkeeper, in combination with others, might obtain the use of the telephone for his customers, and save a vast amount of the trade now going to the Civil Service Stores by such means as this. The other reason for the restriction of the telephone applies to City life. It consists in the comparative cheapness of messenger lads in London to that in America. Any number of lads can be obtained for a weekly wage of from four to five shillings—equal to one dollar—a week, and while this is the case it pays City houses and companies to employ a staff of lads to continually take their messages by hand, rather than to pay for the use of a telephone. The service is quick, intelligent, and has the advantage that packages, as well as messages, can be sent. In America, except in the near East, the case is often quite different. Men, or even lads, are difficult to obtain at all as mere messengers, except at what would be prohibitive rates, and therefore the telephone performs this function with great profit.

Weston's New Alloys for Electric Conductors. In seeking for a means of obtaining a conductor having a constant resistance at all temperature, says the *Electrical World*, for use in electrical instruments, resistances, &c., Mr. E. Weston has recently discovered two new alloys which accomplish the desired object. He has discovered, in the first place, that the metal manganese imparts a very high electrical resistance, and, in fact, a higher specific electrical resistance than can be obtained by the addition of any other metal to alloys, into which it enters as a constituent; and, second, that the addition of the manganese has the further remarkable property of rendering the electrical resistance of such alloys nearly or quite constant under varying conditions of temperature. Thus an alloy of manganese with copper produces a conductor having the above characteristics. This alloy is made by the common process of melting the two metals; but in practice Mr. Weston employs ferro-manganese on account of its greater cheapness, and this he mixes in the proportions of copper, seventy parts; ferro-manganese, thirty parts or thereabouts. This alloy is capable of being rolled and drawn, and is made up into wire in the usual way. The exact proportion of the metals used may vary somewhat; but while Mr. Weston has found that the addition of manganese or ferro-manganese in any proportion to copper is an advantage, so far as preserving a constant resistance is concerned, he finds that the best results are obtained by the use of the proportion given above. Mr. Weston has also discovered an alloy, the resistance of which is lowered by an increase in tempera-

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ture, a property heretofore lacking in metallic conductors. This alloy, the resistance of which lowers with increase of temperature, is composed of copper, manganese or ferro-manganese and nickel. This may be used for one portion of a coil and copper or german silver for the other, so that should the coil be heated by a current, or otherwise, the changes of resistance in the two portions of the coil will neutralise each other. To secure an exact balance is a matter easily determined by adjustment of the lengths of the two portions of the coil, or by the relative proportions of the metals used in the alloy. Mr. Weston employs with german silver or copper an alloy containing from sixty-five to seventy parts of copper, twenty-five to thirty parts of ferro-manganese, and two and one-half to ten parts of nickel.

Prof. Gray's Telautograph.—The daily press are going wild over another discovery. This time it is Prof. Elisha Gray, not "Prof." Edison. We have heard rumblings of a wonderful development of this instrument for telegraphic transmission of a person's writing—which, by the way, is named "telautograph" (meaning "own writing to a distance"), and not "tetantograph," as the *Daily News* and *Pall Mall* originally had it. No details are to hand except that the instrument consists of a transmitter and a receiver, and uses a pulsatory instead of a variable current. The invention is reported to work so accurately and rapidly as to give promise of being commercially successful. It is a pity that some circumstantial details are not cabled over, besides the mere statement that it has been done. If Professor Gray or Edison were suddenly to announce that they had succeeded in inventing an instrument to telegraph to the moon—giving no details—the Press would, no doubt, immediately commence to "boom" the thing. However, from what is stated, the inventor has lost no time in interesting capitalists, and in attempting to get to work. The following are the latest particulars as given by the New York correspondent of the *Daily News*:—"An immediate effort is to be made to apply Prof. Gray's new invention, the telautograph, to commercial uses. The Judge of the Circuit Court of Richmond, Virginia, has just granted a charter for the purpose of working the invention. The charter is granted to a company the general objects of which are declared to be "to promote, establish, and maintain the general business of a telegraphic, telephonic, and telautographic company within and throughout Virginia and other States and Territories of the United States, by the use of electrical or other devices suitable or applicable to the same, and particularly by means of what is known as the telautographic system, invented by Prof. Elisha Gray, for the transmission of messages or other communications written out in ordinary script, or otherwise suitably prepared for such transmission, and the automatic reproduction of the same at the office of destination, including any extension or improvements of the said system hereafter devised for or added to the said telautographic system, and any other telegraphic or telephonic device to be used in conjunction with each other or separately, as may be found expedient, and any other methods of electrical intercommunication to be used if desired." The charter further authorises the purchase and use of lines, poles, and wires, fixtures, stations, exchanges, or other facilities, including submarine cables, to work the system. The capital of the company is not to be less than 500,000dols., nor more than 15,000,000dols., divided into shares of 100dols. each. The company may hold 10,000 acres of land in each of the States and Territories. The principal office will be in Richmond, with branch offices where needed. As soon as 600,000dols. are subscribed the company will commence business. Some of the largest capitalists in the country are said to be interested in the enterprise."

E.P.S. Catalogue.—We have received a new edition, dated July, 1888, of the Electrical Power Storage Company's catalogue of accumulators and fittings. The book is very handsomely got up and fully illustrated, containing detailed particulars of the company's manufactures arranged and tabulated in order, comprising the "E.P.S." accumulators in great variety; ordinary types for lighting or general purposes, special types for tramcars, railway-carriage lighting, telegraphic work, medical work; also all accumulator necessaries, switches for one up to a thousand amperes, automatic regulators and cut-outs for use in central stations, measuring instruments for use with accumulators and main switch-boards, with detector, hydrometer, and other necessary apparatus. We notice a special form of hydrometer Hick's patent, consisting of a flattened tube, with bent end to hang on the edge of the glass cell. The tube is perforated to allow free circulation of the battery solution, and small glass globules, coloured differently, are contained within the tube; these rise or fall at certain distinct specific gravities, and the condition of the liquid can thus be very readily observed. Several ingenious automatic regulators and alarms are illustrated; in that for train lighting a soft iron coil attached to the switch lever reduces the number of cells on increase of current to avoid over-incandescence of the lamps. Automatic bells are shown which give an alarm when the cells are discharging above their normal rate. A modification of this apparatus, instead of ringing a bell, is arranged as suggested by Messrs. H. Lea and Thornbury, so that a resistance is alternately switched in and out, causing a pulsation of the light, which can only be rectified by reducing the number of lamps until the current does not exceed the normal rate of discharge. A special department is included for hire of fully-charged batteries for temporary lighting at a price equal to one shilling an hour for six hours, for a battery giving 22 amperes. With a view of giving customers the full benefit of the latest type of cells an exchange department is arranged with special prices for complete exchange of old type plates for new ones, utilising wherever possible the original glass boxes. Special insulators for erection of the sets of storage batteries are illustrated; these are glass insulators of mushroom shape, standing in a strong cup of non-evaporating oil. These effectually prevent leakage from the base of cells. For cells where the plant is required to work automatically, or for considerable periods without inspection, such as for tram work, launches, or railway lighting, a special form of celluloid separator is provided, the use of which removes all possibility of short-circuiting. We are very pleased to see the constant and varied improvements which are made by the Electrical Power Storage Company in their batteries, not only in minor details, but in special forms to meet the various applications required. The progress gained is not only to be seen in the greater adaptability of the various types, but is making itself felt in the large increase of life of the batteries. The considerable increase in the allowable output of the new types of cells—close upon half as much again—is a most material gain, not only in reducing the weight where the cells have to be carried, but in diminishing in corresponding ratio the first cost of batteries for a certain output. Illustrations of the application to electric launches and to tramcars are also given in the catalogue.

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ELECTRICAL ENGINEERS.

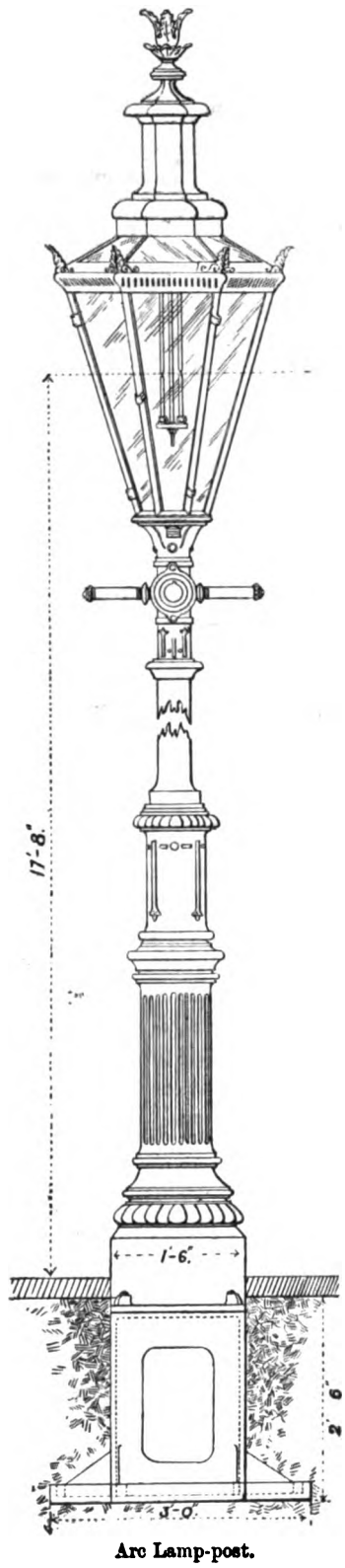
II.—THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION, LIMITED.

One of the largest and best-equipped electrical engineering concerns at present in existence in England is that of the Anglo-American Brush Electric Light Corporation, of Belvedere-road, Lambeth, S.E. This company, which was originally formed, as is well known, to carry out the inventions of Mr. Charles F. Brush, of the United States, and which has effectually familiarised English people with this method of arc lighting, known as the "Brush" system, has for a long while extended its operations beyond those of the Brush patents, and now embraces in its inventions and manufactures practically the whole field of ordinary electrical engineering. Besides the complete system of Brush arc machines and Brush arc lamps, this corporation has specialities for the well-known Victoria incandescent dynamos (low tension system) and the Victoria incandescent lamps; low tension arc lamps, for parallel working on incandescent circuits; the Mordey alternating-current generator and transformers; constant-pressure dynamos, for train lighting; special dynamos for utilising windmill power; search-light projectors, for naval and military use; Raworth's combined friction-gear plant, for incandescent stations; Brush direct-driving plant; electro-motors, working from 2 h.p. up to 100 h.p. and over; and special electric tramway apparatus. We have recently taken an opportunity of visiting the works, and of ascertaining the methods of business adopted by the corporation, and at the present time of prospective development are glad to be able to give so good an account of their business.

While recognising the extreme importance of securing the best and most successful means of dealing with the technical part of the electrical engineering problems, the management of the Anglo-American Brush Corporation have felt that if a company such as theirs is to deal successfully with the vast extensions of electrical work which are soon to come before the world, a sound commercial basis, both as between themselves and others, and between their own employees, is not less necessary to final success. One of the points, therefore, that they have kept prominently before them is to arrange the whole of their business transactions on a thoroughly commercial basis from exactly the same outlook as any other large engineering enterprise. Besides this, they have taken trouble to introduce several features which will tend to make the whole of the organisation work together with ease and with mutual benefit. For this purpose an arrangement has been made whereby a portion of the net profits of the company, a certain per cent. of the dividends, is set aside for distribution, in proportion to their salaries, among such of the officers who have been nominated by the board as participants. Anyone is eligible to be nominated who has been a servant of the corporation for a certain period, and has not contravened the rules of the scheme. The interest of the staff is thus made identical with that of the shareholders, and a considerable economy is effected in a number of small things which it would be perfectly impossible for the heads of departments to control. The system has already produced very gratifying results. A further step in this direction has been the establishment of a sick benefit club, founded entirely by the workmen and the officers and directors working together, the workmen contributing a small amount voluntarily out of their weekly earnings to provide a sum in case of sickness. There are close upon 200 subscribers to this club, and the reserve fund already amounts to a considerable figure.

The corporation have likewise tried to take a long-sighted view of the extension of the electric lighting industry, believing that the benefit of the whole trade will result in their own continued prosperity. The corporation have, therefore, devoted a large amount both of time and trouble to such questions as the amendment of the Electric Lighting Act, an immense amount of work for which has been done in their offices, the chairman of the corporation—Lord Thurlow—introducing and carrying the Bill in the House of Lords. Again, there is the Electrical Trades Section allied to the London Chamber of Commerce. The initiative which has lately resulted in practical action was largely due to the energetic manager and secretary of the corporation, Mr. Emile Garcke.

For the training of competent electrical engineers and workmen the corporation have long introduced a system of pupil training and apprenticeship for the proper training of skilled electricians, and have always eight or ten apprentices on their way through the various departments.



Arc Lamp-post.

The purchase-hire system, as applied to electric lighting plants, was also a very advantageous innovation introduced by the Anglo-American Corporation. During the present more or less depressed state of trade there are many establishments having no great amount of capital to spare, who have been enabled to increase the usefulness of their factories without any necessity for immediate large expenditure by adopting the system of payment. It may also be noted that the reclassification of railway freights, by which a large saving is annually effected by firms engaged in the

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electrical trades, was largely due to the efforts of the Brush Corporation.

The prevailing object in the management of the Corporation's business, during recent years, has been that of economy; and so thoroughly has this principle been adhered to that, although the volume of their transactions is now nearly three times greater than it was five years ago, the expenses of management have been reduced by over 40 per cent. This result is the more remarkable when it is borne in mind that a great deal of the Corporation's work in the past has not been done in the hope of immediate profit, but rather to improve their position in view of the revival of the business, and to pave the way to the extension of operations.

With these remarks as to the manner in which the Corporation have addressed themselves to promoting the development of the electrical industry in this country, we will now proceed to give some description of the works and manufactures carried out by this company.

The Works.

The works of the Anglo-American Brush Corporation occupy extensive premises, situated in Belvedere-road, Lambeth, near Waterloo Station, and just over the Charing Cross foot-bridge. Passing first through the general offices, where the whole of the commercial part of the business is carried on, and in which the board meetings take place, we come to the drawing office, where a number of draughtsmen and designers are constantly engaged, nearly every estimate sent in or contract received necessitating some amount of designing work or illustration.

Engine Power.

The engine power used for running the works is separate from that used in testing dynamos. The works' plant consists of two Galloway boilers, supplying steam for the Galloway horizontal stationary engine, indicating up to 150 h.p., which drives the lathes, drilling and shaping machines, and other machinery in the works. Two Fowler multitubular semi-portable engines are used for testing the dynamos and motors before being sent away, or for any similar auxiliary work.

Machining and Fitting Shop.

The machining and fitting shop occupies the whole of the ground floor, and in this the work of shaping, turning, planing, and drilling the heavy parts of dynamos and other electrical apparatus is in progress. We see here on one shaping machine, eight sets of huge magnets, 10in. diameter of forged wrought iron, simultaneously shaped and slotted for the large 60 unit dynamos now on hand. Drilling and shaping machines are busy all around; in the corner are stamping machines stamping out pieces of copper, and metal cutting machines slicing up rings of solid copper tube into segments of the required size for use as commutators on the large Brush arc dynamos. These are all made to gauge, so as to be readily interchangeable. Further along we see the bevelled pieces of copper, arranged in numerous series on a ring, ready to be formed into the Victoria commutators. This, though composed of dozens of separate strips of copper, each separated by its mica insulating sheet, with no metal to metal, and without ordinary opportunity of mechanical joint, is yet bound together entirely by hand till it forms one block, perfectly smooth and true, and as solid as a single piece. The copper bars are rolled true, just touched up with the file; the double piece for connections is tinned, soldered, and then riveted thereto, and the end soldered to the armature wire and turned over.

A "Brush" engine, designed by Mr. Raworth for use with Brush dynamos, described later on, and Raworth's rope gearing is being fitted up. This latter is the form of gearing for use with ropes instead of belts for transmission of power, which has been adopted with advantage in some cases by the Corporation. A stout rope passes continually eight times round the driving and driven pulleys, crossing in one guide pulley; this does away with all special tension on the ropes, and makes the whole run very quietly and evenly. Pulleys, bearings, belt tighteners, and other apparatus are also being manufactured.

Smiths' Shop and Furnaces.

To one side is the smiths' and foundry shop, where work necessitating the heating, welding, and melting of metals is carried on. In the same department are the furnaces used in the manufacture of the Brush company's "Victoria" lamps.

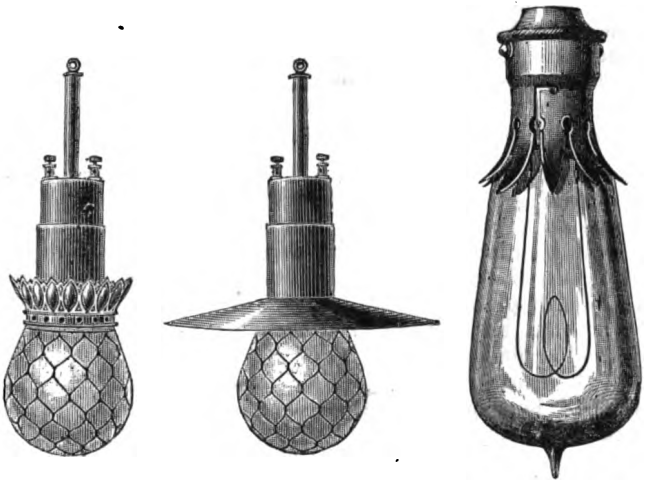
Dynamo Erecting Shop.

This is the name of the department where all the different parts of the machines are brought together from the various other departments, and are fitted and bolted together, connected up and finished off for use in electric lighting, &c. Here we see dynamos—arc and incandescent—and motors, large and small, being fitted together, or ready to be sent away. Some of the heavy dynamos for export are specially made to be easily taken to pieces by drawing four bolts. By this means the heavy magnets can be separated, leaving the magnet coils still connected. In the larger sizes, or for special transport, these can be still further disconnected, and by taking off the bearing caps the whole of a 500-light dynamo comes into parts, which can easily be lifted by a couple of men. One illustration of the strength of make of the Brush Corporation's Victoria dynamo is that of a 30-unit machine, sent to an overhill place in New Zealand. The carriage employed to transport one of the large and heavy magnets unfortunately overbalanced at the edge of a rocky gorge, and the whole was precipitated on the rocks below. Help was obtained, and the magnet fished up; the horse was quite dead, but the magnet was not, though it had bounded far away among the rocks. The machine is still working and doing its duty well.

Parts of the new Mordey Alternator are to be seen, and electromotors for hauling, pumping, and traction work are under progress.

Light Fitting Department.

Going up the lift, we come to the light-fitting shop on the first floor, where long rows of light lathes,



5 Ampere Arc Lamps. Victoria Incandescent Lamp.

power presses, drilling and stamping machines are occupied with the smaller parts of dynamos, and in the manufacture of arc lamps, lamp rods, brushes, switches, and other fittings. Here we see the celebrated Brush arc lamps (2,000 n.c.p.) in process of manufacture, the parts of which are made with the very greatest accuracy. The celebrated little Brush "clutch," by which the regulation of the Brush lamps is effected, about which there have been so many lawsuits in the United States, can be seen in process of manufacture, together with the metal brush connections for the lamps. Both of these are beautifully finished specimens of metal working, finished true, and lacquered to prevent rust, and all made on the interchangeable system. The inside electrical arrangement of these lamps is exactly the same as when first introduced from America, with the exception that the ratio of winding is slightly different to obtain a more sensitive feed, and the external appearance is somewhat different from the American type of Brush lamp. Otherwise, the lamp is practically unaltered, which speaks well for the perfection of the first invention.

The 5-ampere Sellon arc lamps are also greatly coming into favour, large numbers having been made for use on low tension circuits in parallel with incandescent lamps.

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The appearance of these lamps is shown in the cuts both for public buildings where a moderate arc light is required, and for warehouses and shops.

Resistances for use in electric light circuits are made in this department. The use of platinoid wire, lately advocated before the Society of Telegraph-Engineers by Sir William Thomson, has been adopted for a considerable time by the Corporation, who have appreciated the property of this wire in remaining of approximately the same resistance at whatever temperature it may happen to be. Resistance frames are made up in a simple and fireproof form in cast-iron openwork cases, fitted with small porcelain insulators, and the resistance wire threaded through these. They are thus beyond possibility of setting fire to surrounding woodwork, and allow ample ventilation.

Winding and Pattern Shop.

On the top floor we come to the winding and pattern shop. The winding department is, perhaps, the most delicate operation experienced in the manufacture of dynamos, and necessitates clean and careful handling, and freedom from all metallic particles. It is, therefore, placed on the top floor, where only wood working is also carried on. We see here the various coils and armatures in process of manufacture; heavy shuttles of insulated copper wire being carried under and over the coils by hand, firmly pressed into place, and made as solid and as firm as possible. In the case of the cores of the Victoria dynamo, long continuous strips of rolled sheet iron are wound off one bobbin, a second bobbin feeding strips of special paper for insulation. For the manufacture of the cores of the Brush arc armature, similar long strips are taken, and stamped pieces of sheet iron are inserted at intervals, the continuous strip binding all into one compact body, to build up the peculiar-shaped armature used for these machines. The stationary coils of the Mordey Alternator are here wound and fixed on their places, and the winding of incandescent machine armatures and those for motors is carried on in like manner.

The pattern department is carried on at one end of the long room, wood work of all kinds being finished for models and patterns.

Testing Department.

Returning to the ground-floor, we come to the testing department. Here are fitted the two semi-portable steam-engines mentioned before, with lines of shafting and pulleys for testing the capabilities and output of the new machines. These will give a combined energy of 150 indicated horse-power, but by a special modification of the Hopkinson method a much greater power can be tested than these can be made to give. If a dynamo requiring several hundred horse-power is to be tested to its full capacity, it is connected by belts to the shafting, and measuring instruments are inserted in the circuit. The current which it generates is led to another dynamo, which is coupled as a motor, and a belt from that is taken back upon the shafting. When this combination is running, as much as two or three hundred h.p. can easily be thus transmitted to *the belt driving the dynamo*, which returns its energy by way of the motor to the shafting, the engine merely supplying the difference in friction and loss in conversion, and thus doing away with the necessity for very heavy engine power. Siemens' dynamometers are used in these tests, together with Ayrton and Perry ammeters and voltmeters, and Cardew's voltmeter. Thomson's mirror reflecting galvanometer, with a Wheatstone bridge, is used for more delicate tests for insulation and resistance. The use of a special instrument-room, quite away from the dynamos, has been found to be very inconvenient and more inaccurate than the method of testing adopted, which is to take tests with the instruments placed on movable tables, moving them about in different places, and taking several readings, reversing the connections, and thus checking the results, which are then always under the eye of the person testing.

For testing arc lamps there is an arrangement by which 80 lamps can be tested simultaneously. A platinoid resistance is also strung in wires overhead, the resistance of which, cold, is accurately known, and is without self-induction. This is used for testing Alternators. A resistance of several hundred incandescent lamps is used for testing incandescent machines, and special wire resistances of 10 ohms can be used in parts or connected in parallel for resistances of one-tenth or one-hundredth of an ohm.

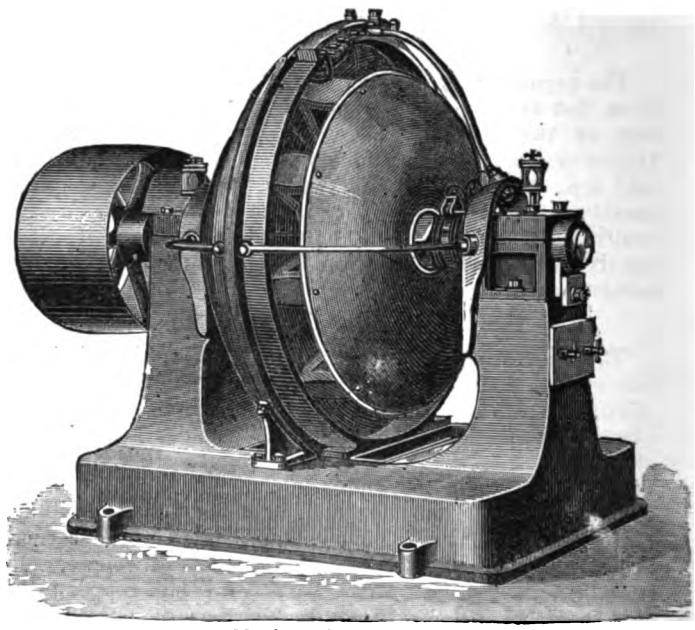
Incandescent Department.

A special department, in a separate building, is organised for the manufacture of the Victoria incandescent lamps. For eight years, since the inventions of Lane-Fox were first secured by the Corporation, the manufacture of incandescent lamps has been carried on even before the time of the invention of Edison's lamp, and the evolution and development of this lamp has gone on apart from that of other makers. A vacuum pump is used for assisting the exhaustion of the lamps, which is done by means of modified Sprengel mercury pumps, producing the nearest approach to a perfect vacuum attainable. The complete process, from the glass-blowing to the finish, is carried on in this department, preparing the filaments, mounting, sealing, and exhausting, the work being done mostly by girls.

A description of the process in its principal points was given in the recent trial, the lamps being made without any use of the Cheesborough process of "flashing" for standardising, the whole process being a development of the early manufacture of lamps under the Lane-Fox patents.

The Brush Dynamo.

This well-known machine is made in considerable numbers for all parts of the world. Dynamos for a total number of 8,000 arc lamps have been made for England since their



Mordey Alternator.

introduction. The usual large size of machine will supply 55 arc lamps, with 10 amperes of current each, at a total E.M.F. of 2,700 volts. Some idea of the strength of this current may be obtained when it is stated that one of these machines would light a 10 ampere search lamp (through properly insulated cable) at a lighthouse through 200 miles of No. 6 wire—that is to say, at 100 miles from shore. Smaller sizes of these dynamos are made for 10, 15 and 23 arc lamps.

The Victoria Dynamo.

This dynamo is also well known, and is for supplying current for the small incandescent lamps. It is compound-wound, being electrically self-regulating for any number of lamps from one to its maximum; or can be made to keep a constant pressure at a certain position at a distance, as might be required when water-power is some distance away, and allowing for a normal loss in the cable. The dynamos are made to supply from 15 to 1,000 16 c.p. incandescent lamps, and are in use on board ship, in public and private buildings, and for the various Governments all over the world.

The Mordey Alternator and Transformer.

This plant, which is a comparatively new feature of the Brush Corporation's electrical engineering operations, has

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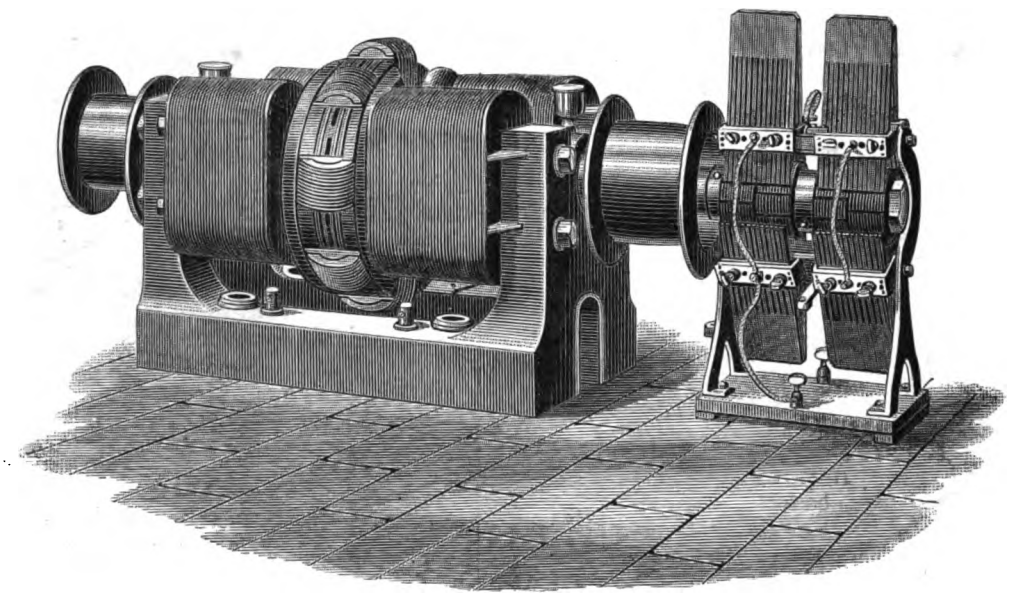
been described and illustrated in this journal for June 15, page 558, and consists essentially of the adaptation of strong mechanical arrangements for high tension alternate currents for use with transformers. The chief feature of this alternator is the heavy revolving magnet. If one imagines a huge iron mushroom, of which the stalk is wrapped with wire, and thus becomes one pole of a magnet, the edge of the huge mushroom-shaped ring being the other pole. This is cut into nine portions, becoming, of course, nine large south poles. The second mushroom ring consists of nine large north poles, and both these on one axle revolve rapidly past the induction coils. The coils, being the more delicate portion of the whole apparatus, are stationary. Each coil is separate, and can be disconnected by unscrewing four bolts and breaking the electrical joint. Each coil can be disconnected and taken out without otherwise disturbing the other parts of the Alternator. The first of these machines is at use at the central station in Black Horse-yard, Oxford-street, and a second is being made for the same place.

The Transformer is of a very simple form, recently illustrated in our columns Mr. Mordey considers it essential to the practical working of transformers that they should always be worked well within their limits, and thus require no attention. Those in use at the above-mentioned station are simply locked in a small compartment, and have not required the slightest attention since fixing.

Train Lighting.

The lighting of trains by means of a dynamo fastened to the axle has been effected now for some years with the use of Brush dynamos of a special make. The dynamo used has not, as far as we know, been illustrated hitherto, and we give herewith an illustration of it. It is an ordinary Brush arc dynamo wound in a special manner to give a constant E.M.F. at all speeds. There are two sets of brushes on each commutator, one set connects automatically when the train is travelling forward, and the other set when on the reverse journey. This arrangement has been in use on the London, Brighton and South Coast Railway, and also on the Great Northern Railway.



Brush Train-Lighting Dynamo.

This, by means of a governor-ball arrangement, completes the circuit when the train has attained the speed of 10 miles an hour, and from that speed up to the quickest of 50 or 60 miles an hour, the pressure is practically constant, the current only increasing, without any automatic device except the first cut-in. When the lamps are turned on they are fed direct from the dynamo, the excess going into a set of 26 accumulators kept in a locked compartment of the guard's van. These feed the lamps when the train is at a standstill, and in operation the arrangement requires no supervision, the whole being perfectly self-acting. An illustration of the perfection of the electric regulation as the speed increases was obtained some little time ago very forcibly, by a wrong pulley having been inadvertently put on by the railway company. The guard did not notice anything until the full speed began to be obtained, when the dynamo began to hum with the excessive speed, attaining a speed of, perhaps, 3,000 revolutions per minute, and causing the guard some fear for his personal safety. But the pressure did not increase, and nothing wrong was noticed at the lamps, nor anywhere except the extraordinary speed of the dynamo.

Windmill Lighting Plant.

For many years there has been talk of deriving power from windmills, and storing the energy by means of accumulators. The Brush Corporation, in the summer of 1887, carried out an installation on this principle. This was for the Duc de Feltre, acting, we believe, partly on behalf of the French Government at Havre. The plant consisted of two special Victoria dynamos, arranged with automatic circuit closers. One of the dynamos started, when a speed of 120 revolutions was attained, and continuing to 400 revolutions. The second one then took up the running, commencing at 400, and going up to 750 revolutions a minute. At the higher limits of speed there was an electrical cut-off for each dynamo, and a striking gear enabled the attendant to stop the armature revolving. The regulation of the dynamo itself varied the strength of field to suit the altered conditions of speed.

Mr. Mordey made some actual tests upon the spot, in concert with some representatives of the French Government, one of whom was the engineer to the electrical and engineering departments of the coming French Exposition of 1889, another being the Duc de Feltre. The tests showed an efficiency of over 90 per cent. of the power absorbed from the windmill. The E.M.F. was 75 volts, and the current varied from eight amperes at 120 revolutions to 160 amperes at 650 revolutions.

Ship Fittings.

A very large number of ship fittings are made and fitted by the Brush Corporation themselves. Mr. Raworth has had large experience with this kind of work, and has designed many fittings for ship work, overcoming the difficulties which were first experienced in procuring thoroughly satisfactory fittings for use on board ship. The Brush Corporation have made ship lighting one of their special features, having fitted a large number of the great liners and English and foreign men-of-war, including a very great number—in fact, the greater proportion of those fitted—of torpedo boats.

Some side light lanterns for ships having some special features of novelty were also shown at our visit. These consist of an ordinary strong copper ship's lantern, in which the usual oil lamp is replaced by two incandescent lamps. These are mounted on a pivot actuated by a spring; the man in attendance turns this pivot round, bending the spring, and a detent keeps one of the lamps in position,

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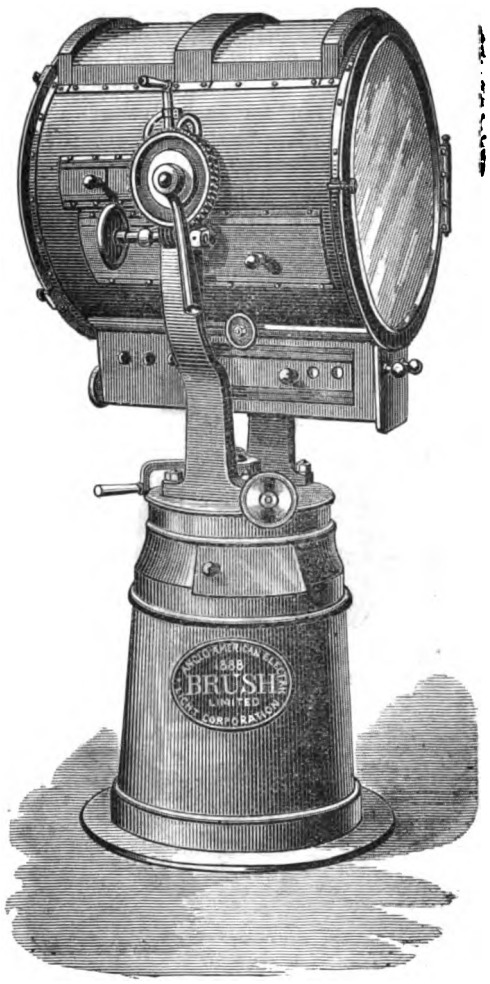
and at the same time lights lamp number one. If any accident happens to this, and the lamp goes out, the breaking of the current releases a spring on an electro-magnet, and relieves the detent; the pivoted arm revolves, and brings lamp number two opposite the reflector, and lights it up. This arrangement is extremely useful where it is absolutely necessary a light should always be shown.

Search Light Projectors.

One of the principal adaptations of the electric light to ship use is that of search lights. The arc light for this purpose is of very much greater candle-power than the ordinary arc lights, which are nominally 2,000 c.p., taking 10 amperes of current. The search light for projectors often take from 75 to 150 amperes of current, giving a light of 30,000 c.p. One of these arc lamp projectors is shown in our illustration for use on board ship. The thick carbons are regulated by a hand feed, and the movement of



Search Light Projector.

the lantern is effected in two ways—by hand, for rough adjustment, in which case the lower handle, which operates a locknut, is loosened, and the whole lantern then moves by hand; and for finer adjustment the lock-nut is tightened, and the worm gearing serves to effect any desired degree of elevation or depression. A feature lately added to these projectors is the flashing arrangement for sending signals. The upper handle shown operates two discs of blackened sheet metal, closes them together with one motion to allow the full beam to pass, and opens them out with the reverse motion to cut off the light; by this means long or short flashes can be used to signal in the Morse code.

These projectors are also much used for navigating difficult passages at night, especially in the Suez Canal, where special apparatus is arranged on the stem of the boats, with a look-out man to discern the way. An illustration of the Suez Canal projector in action is given.

The "Brush" Direct-driving Plant.

This is a combined plant for incandescent lighting for situations where a compact arrangement is required and where a slow speed is available. It is a type of engine designed by Mr. Raworth, a simple and compact form of vertical engine of a thoroughly substantial and practical character, such as any practical engineman could look after. It is largely used for ship lighting, with which the corporation is always more or less occupied. The ship-work is a constant source of occupation even when other work is flagging, many of the fine ocean steamers being entirely fitted with Brush plant.

One of the last plants of this kind recently supplied has run out to Australia and back with total stoppages, day and night, of only 23 hours, which, remembering that these stoppages were when the ship was in port and idle, and not because of any electrical or mechanical difficulty, is probably one of the longest runs made by a dynamo on board ship, and is a regular thing with these ships running to the Antipodes.

The Raworth Friction-Gear Installation.

This plant, which has been favourably noticed in many places, is a combination of low-speed engine with high-speed dynamo, the speed for which is obtained by a balanced friction-gear. A plant of this kind is running at the Brush Corporation's works to supply light for the offices, &c., and the whole plant for 130 lamps is contained in a

Suez Canal Projector.

small apartment not much larger than a cupboard. The over-all measurements of the plant are 7ft. high by 7ft. broad and 4ft. wide. A small Brush engine of the type above mentioned has a large pulley-wheel fixed to its shaft; resting on this is the small pulley of the dynamo, and kept pressed against it by a strong spring. The periphery of the small pulley is covered with a hard layer of paper, and the dynamo itself is hung on trunnions to allow of a slight yield. The advantage of this combination is that the whole plant takes the smallest possible floor space, and retains both the advantage of a high speed for the dynamo and low speed for the engine. It takes, in fact, *less* room than a direct-acting engine and dynamo of the same power, and the engine is enabled to be of a type which is suitable to be placed in the hands of any ordinary workman, who might not be able to deal with the special provisions of an ordinary high-speed direct-driving engine.

A tachometer is attached to indicate the speed of the engine, but the governor acts within a small percentage of normal speed. Two governor belts are fitted in case one breaks, to prevent racing of the engine. There have been over 200 sets of this plant supplied for use on board ship. That now in use at the Brush works has been used for continuous testing of incandescent lamps for 'length of life,' and has run for the last four or five weeks continuously night and day without hitch.

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Educational Dynamo.

A small type of dynamo, for use in educational establishments, technical colleges, &c., was shown. This has been made for the Heriot-Watt College, Edinburgh. The fields can be connected in any variation—series, shunt, compound, in multiple of two, four, or eight sets, for use in experimenting. One special coil has a special commutator of its own, by means of which the strength of induction in various parts of the field can be experimentally determined, and the strength of the field and other factors can be mapped out. This ought to prove itself very useful in its peculiar department. The machine supplied is used for charging accumulators and driving a motor at the college.

Motors.

Several types of motors were also shown; one of these, a small motor working up to 2 h.p., was shown driving a fan. A special iron-clad motor was also noticed, very strongly made, and shielded for use in mines; this is strung up by an eyelet bolt, and can be drawn up and down the mine shaft, and will stand a great deal of rough usage.

The type of machine intended for the motors for this undertaking will each be capable of working up to 20 h.p. Each locomotive will carry a considerable load of parcels and goods, and, in addition, will draw a heavy passenger car. The system to be used is the overhead line; the station will be situated in the middle of the line, which is not a circle, but a straight out and home line equal to ten straight miles. The current will be taken off in parallel, and the plant will be capable of operating sixteen locomotive and goods cars with attached passenger cars.

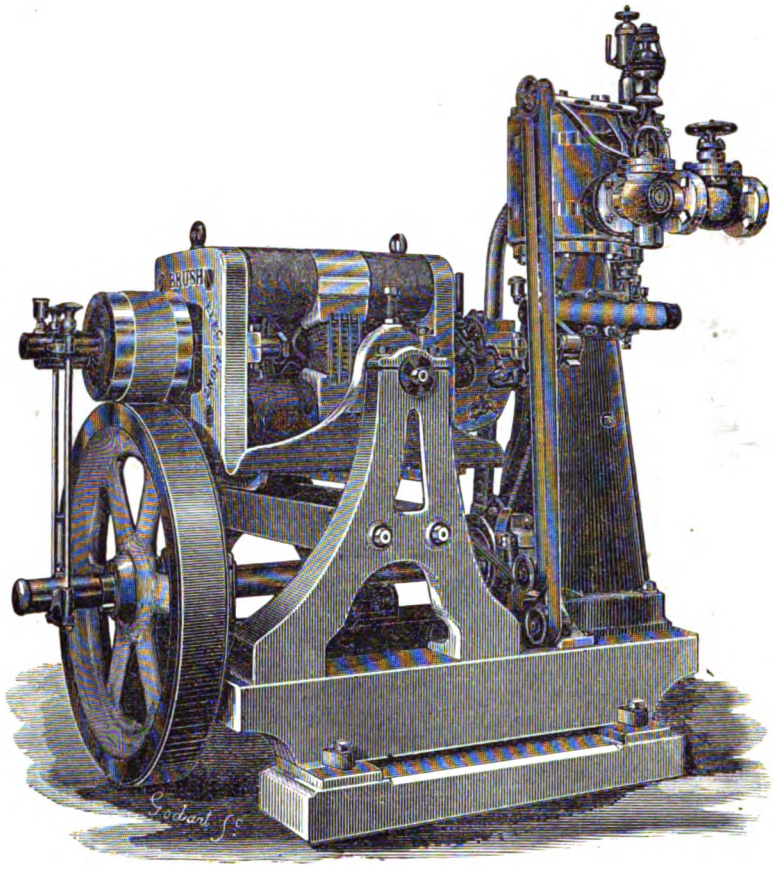
Electro-Deposition and Separation.

The use of dynamo machines for electrical treatment of ores dates from the manufacture of the historical compound-wound Brush plater. The immense "Colossus" Brush dynamos are made for use in the aluminium process taking 400 h.p., and for copper deposition the corporation has supplied a number of low-tension Victoria dynamos.

General Remarks.

We have thus given a comprehensive survey of the work and resources of the Anglo-American Brush Electric Light Corporation, and from what has been said it may be imagined that this enterprising concern, being fairly settled to good work, will be able to deal with its share of the coming lighting schemes. One indication of the way in which the corporation can attack a large influx of work is given when it is mentioned that on receipt of the order for the Melbourne Exhibition for complete plant for 1,000 arc lamps and 3,000 incandescent lamps and all accessories, not any of the necessary plant was in stock, yet the order was accepted and completed for the 40 25-lighter dynamos with lamps and complete plant for the 3,000 16 c.p. incandescent lamps within a period of two months. For the Glasgow Exhibition, likewise, plant for 550 arc lamps was supplied by the Corporation, and a large number for the Barcelona Exhibition, besides the complete arrangement for the illuminated fountain.

Apart from the factory at which they are now working, and which itself is capable of considerable extension, the corporation have a factory in Vienna, and working arrangements with other manufacturers on the Continent. In addition to this, they have other premises in England which can be opened up as soon as the demand for further factory accommodation arises.



Raworth Friction Gear Plant.

Motors giving up to 70 h.p. were also shown; two of these have just been supplied to a foreign Government for use in a factory where water power is available, for driving the factory machinery.

Current Indicator.

A very useful current indicator designed by Mr. Raworth is now in use by the Brush Corporation on their arc circuits. A simple coil wound with wire, to go in series with the circuit, has supported in it a small soft iron piece, which is drawn in, and thus moves the pointer. This is not a solenoid and core, as might appear, but an arrangement by which the iron piece is partly *rotated*, being set originally out of the centre of the coil. It indicates with a long pointer the variation from a normal of 10 amperes.

Electric Railways.

The subject of electric traction has been occupying the attention of the Brush Corporation, and it has recently entered into an arrangement to erect an electric railway of ten miles in length, with a heavy traffic, to be worked at a very high speed. This will be, probably, the longest electrical tramway in Europe, and will be the most important undertaking of its kind this side of the Atlantic.

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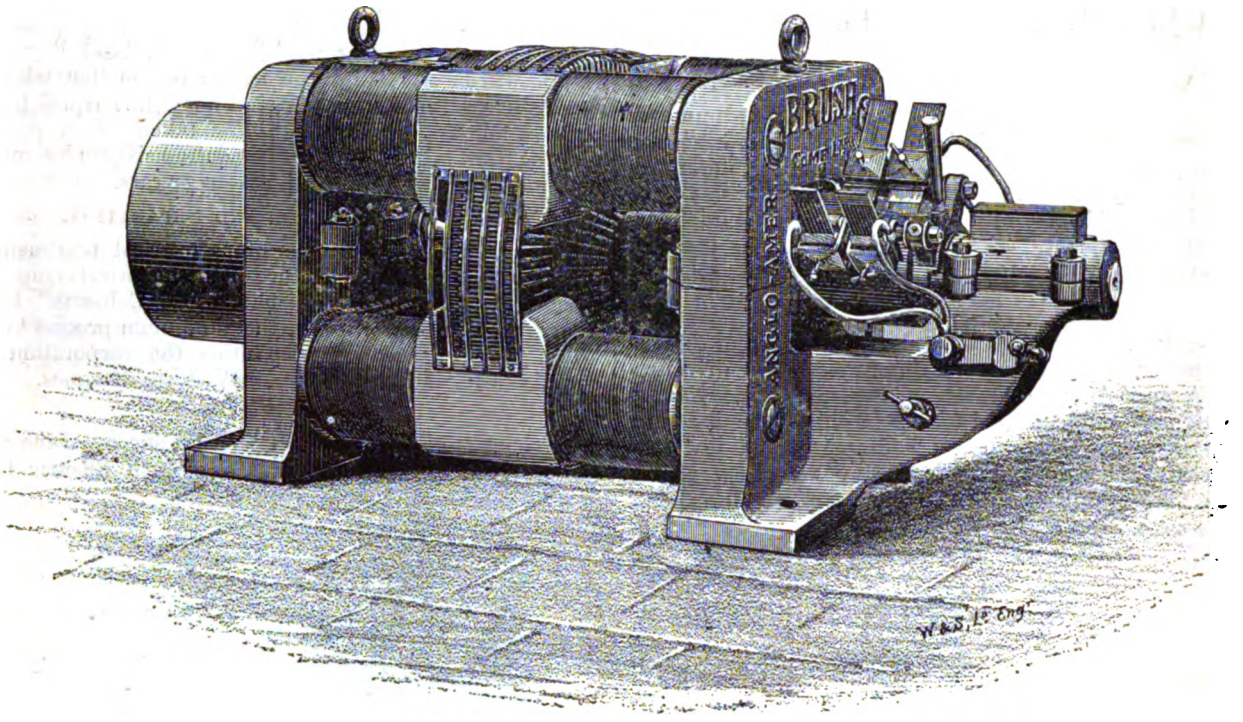
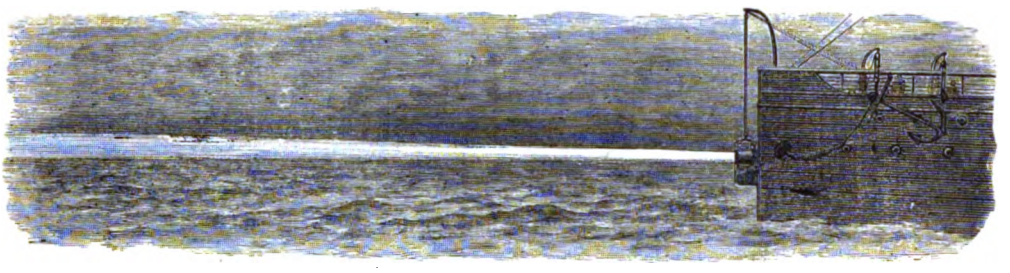
ILLUSTRATIONS OF THE ANGLO-AMERICAN BRUSH CORPORATION'S MANUFACTURES.

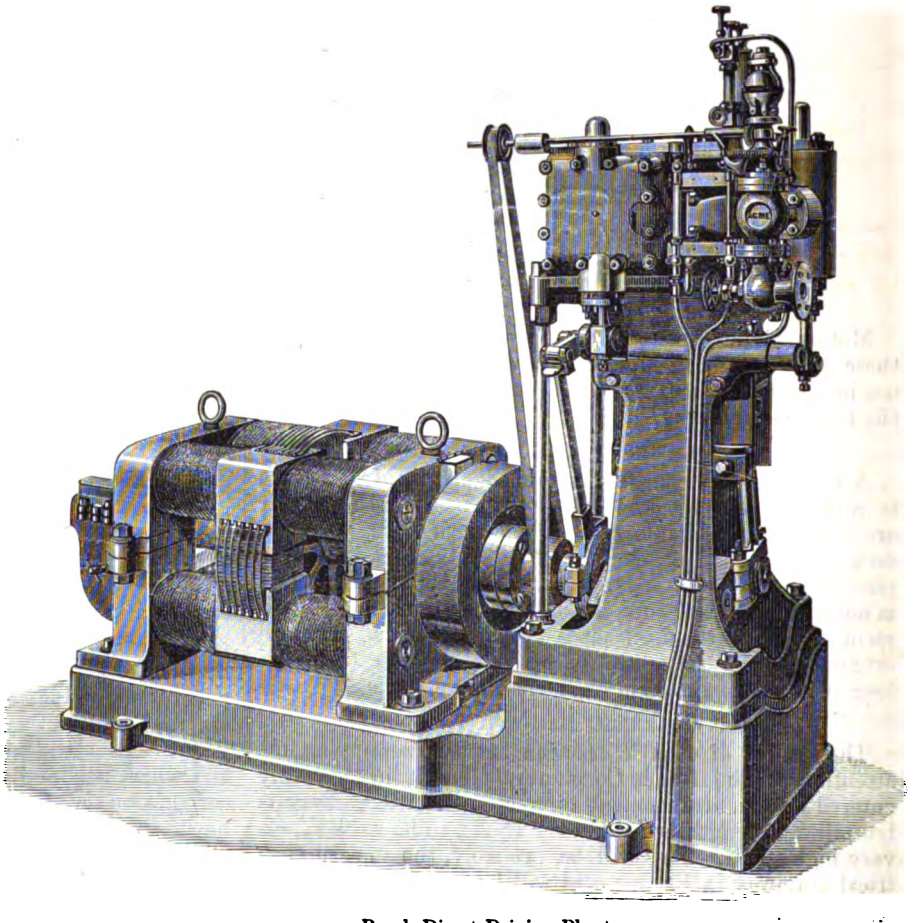


Victoria Incandescent Dynamo.



Projector in Use.

Brush Arc Lamp.



Brush Direct Driving Plant.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

CAUTION.

From his childhood to far into mature age the Englishman is apt to run riot when restrictions are withdrawn. Liberty among plenty at Christmas time leads to illness; indulgence amongst the sweets is very likely to lead to a closer acquaintance with the bitters. The commercial man differs little from the child, while the pure speculator revels in being unrestricted. Readers of hunting literature know how the hunters of America—and for the matter of that in many other places—attract the game. While the hunter himself is hidden, a piece of brightly-coloured bunting flutters in the breeze, and the animal, desirous of knowing more about this strange phenomenon, circles round and round in ever narrowing circles till the fatal spot is passed and a bullet cuts short any further career. The speculator, and in the majority of cases the investor, partakes largely of the nature of the wild animal. The bump of curiosity seems abnormally developed whenever something new is fluttered before them, and if this something new is presented with the high colouring and flavours that promoters know so well how to give, the investor falls an easy prey to the wiles of the money-hunter.

Certain restrictions have been withdrawn from electric lighting, and the charmer is merrily uttering his charm, while we feel it necessary to utter words of caution and to warn intending investors to look carefully into the matter put before them. A buzz of anticipation as to increased work has been heard through the promotion of the Metropolitan Company, with a long list of well-known City men as directors. Now we should like to see such a company succeed, but we fear that this one is not just what is wanted. In the first place, some of the directors have no business on the board of this or any other such company. They have no experience of this class of work, nor is it suited to their idiosyncrasies. Then the company is far too pretentious, and according to its prospectus, if it obtains all the provisional orders it is going to apply for, it will virtually seek a monopoly of the electric lighting of London. So far as its engineering staff or management is concerned, we have no single word of adverse criticism to offer; our animadversions are directed to the finance. Before going further, let us admit with a contemporary that "founders'" shares are a delusion and a snare, even if the promoters have not created them for a worse purpose. At the present moment the capital is half a million, but it is evident that if the promoters carry out anything like their scheme as sketched in the prospectus the future capital will reach five or even ten millions. Now, as we read the prospectus, the *hundred* founders' shares are to receive *half* the profits after 7 per cent. is paid upon the share capital, and to induce subscribers it is pointed out that the

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capital of the gas companies is reckoned by millions—and we all know their profits are more than 7 per cent. What do these philanthropic directors give for these *hundred* shares, and what do they expect to get for them? They give just the same cash price as for ordinary shares, they get upon the present capital £2,500 for every 1 per cent. after 7 per cent. paid. But evidently this is not the summit of their hopes. They can afford to fight the gas companies tooth and nail, to buy up other minor electric light companies—all at the shareholders' expense—for though they apply for a certain number of ordinary shares, there is no compulsion to hold them, and a few days' Stock Exchange transactions will relieve them of the greater part of such shares, and if only in the sweet by-and-by they can see an 8 or a 10 per cent. on five millions of capital their object would be attained. These founders' shares would then bring in a nice £25,000 a year for each 1 per cent. paid over 7 per cent., and would have as high a value as original New River shares. Is it possible that the red rag held out to investors will induce them to agree to pay on these hundred founders' shares £7,500 when £50,000 is paid to the ordinary shareholders? We assume that a fair price has been paid for what the company has purchased, and therefore the 50 founders' shares reserved for the promoters of the old company are given solely for "being in the swim." It is said that investors will be perfectly satisfied with 7 per cent. for their money, and that they invest with their eyes wide open. No doubt in a measure this is perfectly true, and from this standpoint it may be said that far-sighted individuals are quite at liberty to provide if they can a nice little nest egg for their children. That may be commercial or company morality, and if it is, we have nothing further to say. We venture to think, however, the true action of these founders' shares is not realised, nor is it intended it should be, by the present shareholders. There is no likelihood of even 7 per cent. being paid just yet, and probably never while the capital is only half a million. The holders of these founders' shares do not expect it, but nevertheless they hope for a future gold mine, and this deferred payment is an unknown quantity which may be so utterly out of all proportion to any services rendered, that it should be repudiated at once. There is one conspicuous quality among these directors—viz., that hitherto whatever project they have put their hands to, and kept the management to their own clique, has sooner or later returned the shareholders at least a 5 per cent. dividend. If the clique has thrived during the process, it proves they will know how to manage their own affairs as well as how to satisfy shareholders.

We have said the scheme shadowed out by the prospectus is too pretentious; let us walk before we attempt to run. It is sufficient to prove the commercial practicability of electric lighting in one or two large centres before grasping to supply greater London. Investors must recollect that gas is in the field, and possession is, as we all know, nine-tenths of the law. Gas is not going to give in without a struggle, nor has electricity as yet proved its commercial superiority to entitle it to say with Cæsar, *Veni, vidi, vici.* The data extracted from American successes are altogether fallacious. There electric light has had to compete with gas at a high price, or has been installed when there was no gas. In England, its first successes will be in the wealthier districts, among the club houses and large hotels, in shops, warehouses, and theatres, where gas is deleterious and dangerous, in public buildings where decorations are important; but otherwise outside the main streets, in the houses of the middle classes, the artisans and the poor, in the minor shops, streets, and alleys its time is not yet. It will gradually extend in all directions, and it is this natural extension which may at some future date put the outrageous value upon the founders' shares we have referred to above. Hitherto there has been plenty of work in sight, but the capital at the command of the honest, earnest worker has been scarce. The restrictions that have frightened capital have been removed, and there is still this vast amount of legitimate work without endangering progress by too great attempts at once. Every step taken and every company formed should be such as will bear the strictest scrutiny, otherwise it will be very difficult to obtain the necessary funds to carry out legitimate business. In our criticism we have endeavoured to be bold, plain, and faithful. It would, perhaps, be best for peace to let the world go on in its folly, but it seems to us unjust to permit, without question, any body of promoters to mulct a successful company in the future to an unknown amount for a doubtful benefit in applying for a certain large number of shares as underwriters, which, if they obtain and manipulate sucessfully, may be sold even before allotment, and will, if the markets are satisfactory, be unloaded at the earliest possible moment.

THE CHARGE ON THE ATOM.

BY J. ENRIGHT, B.SC., LOND.

(Continued from page 97.)

The doctrine of the charge on the atom undoubtedly attaches a new difficulty to the theory of "dissociation," for how are we to conceive a number of portions of matter charged with electricity moving through an uninsulated conductor without leakage? No matter how short the periods of freedom may be, some portion of the charge would escape, if not to earth, at all events to the liquid, where it would be rapidly neutralised by similar portions of the opposite kind. But as, according to Helmholtz, there is nothing but the mutual attractions of the charged ions to cause them to recombine, a disengagement of ions should be continually going on. From a solution of cupric sulphate, for instance, solid copper ought to be continually breaking away (when under no electrical influence). If it be urged

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against this view that the time during which the ions are free is too short to permit the escape of any portion of the ionic charge, it can be answered that the time is also too short to permit the *feeblest electromotive* force to push it with the ion, to which it is supposed to be attached, towards the electrode. But there is the experiment of Prof. Lodge, already referred to, and briefly described. The atom of barium travelled about 60 centimetres in 21 hours through an uninsulated good conductor, and we are asked to believe that its charge made no attempt during all this time either to escape to earth, or to spread itself over the conducting liquid through which it was driven. Such behaviour is very foreign to our experience of electric charges. This experiment alone appears to necessitate a theory of continuous interchange of ions between the molecules of electrolytes when under the influence of an E.M.F.

I suppose it is impossible to compare the tendency to fracture a molecule by the strain of an E.M.F. applied to an electrolyte with the destructive effect supposed to be produced by an encounter between its molecules. Yet one cannot help remembering in this connection that the strain set up in a dielectric by an E.M.F. is often very great—sufficient to fracture glass—and always capable of being detected, while there is little, if any, reason to expect a very destructive effect from the collisions between the molecules of liquids on account of the shortness of the free path. Maxwell can be quoted on this point: "It is true that the molecules, generally, can travel but a very small distance before its path is disturbed by an encounter with some other molecule." But we know that it requires a considerable expenditure of energy to break up a molecule, because the heat of combination of the ions composing it is considerable. And indeed one would expect that the heat of combination of the component ions of the molecules of a substance ought to be closely connected with its conductuity according to the theory under review. Why is it that in some liquids, such as liquefied hydrochloric acid gas, the encounters are not able to cause dissociation; whereas in others, such as a solution of sodic chloride in water, the collisions appear to be very destructive (because it conducts well)—and we ask this question more inquisitively when we remember that the heat of combination of hydrogen and chlorine is only 44,000, while the heat of combination of sodium and chlorine is 195,000, and of hydrogen and oxygen is 79,600? The compounds of carbon and hydrogen are among the worst conducting liquids, although the heat of combination of the elements being comparatively low, one would expect mutual molecular destruction to proceed amain in their liquid compounds.

I have already argued, from the hastening of the precipitation of $SrSO_4$ from a mixture of $SrCl_2$ and H_2SO_4, by passing a current through it, that the strain set up in an electrolyte by that means tends to fracture the molecules directly or indirectly. There is another aspect of this experiment which I consider of great importance. The strain was very likely only one of the forces, the resultant of which effected the dissociation—the last straw, perhaps. But although it was sufficient to disrupt the molecules of $SrCl_2$ and H_2SO_4, it was powerless to prevent the formation of the new molecules—viz., HCl and $SrSO_4$. Now, this is distinctly at variance with the teaching of Helmholtz, for he lays it down clearly that there are no other forces to draw or keep the ions together but the electric forces—the attractions between the electric charges. "If any chemical force existed besides that of the electrical charges which bind all the pairs of opposite ions together, and required any amount of work to be vanquished, an inferior limit to the E.M.F. ought to exist, which forces are able to attract the atoms to the electrodes and to charge these as condensers. No phenomenon indicating such a limit has as yet been discovered, and we must conclude, therefore, that no other force resists the motion of the ions through the interior of the liquid than the mutual attractions of their electric charges." In a word, there is no chemical affinity as commonly understood. In the experiment under consideration, certain molecules are destroyed by the current, and the resulting free charged ions come under its influence. If, as we are taught, there is no chemical affinity, and if, as we are also taught, "the smallest E.M.F. completely dominates charged ions, how then can the molecules of HCl and $SrSO_4$ be formed until the liquid is relieved from the overpowering influence of the current? When the smallest E.M.F. is credited with so much, we are well prepared to expect very firm government from (say) 10 or 12 volts.

In order to test this point, I passed through a mixture of dilute solutions of $SrCl_2$ and $CaSO_4$ the current from the terminals of the conductors which fed a 20 volt glow-lamp. The platinum electrodes were kept about 2½in. apart, and the time was so short before a precipitate appeared, that there was no perceptible rise of temperature. A portion of the same mixture—the counterpart through which the current was not passed—did not show a trace of turbidity for four or five minutes. I infer from this that although the strain of difference of potential may combine with "residual affinities" to break up a molecule, it is powerless against chemical affinity—against that force, whatever we may call it, which caused, under the circumstances stated, the combination of the ions composing $SrSO_4$ and $CaCl_2$. If, as Helmholtz has taught us, the electric forces were the only forces, I submit that on his theory the charged ions when once set free would be hurried off, without being permitted to notice one another, to their respective electrodes by such an E.M.F. as the electrolyte was subjected to in the experiment described. Without comparing the forces brought into play, I consider that it can be safely inferred that a strain capable of breaking up a molecule by acting on the charged ions composing it is also able to prevent such charged ions from combining to form new molecules. And we have the very words (already cited) of Helmholtz to the same effect.

I have endeavoured to regard these experiments from every point of view, and can find no means of escape from the conclusions I have drawn. It did occur to me that the hastening of precipitation may be the effect, not of any strain due to difference of potential, but to some effect of secondary action. I looked as closely as I could into this point. I endeavoured to ascertain at what part of the electrolyte the precipitation took place, and for this purpose passed a current through straight tubes containing $CaSO_4 + SrCl_2$. It was not very easy to make quite sure on this point, on account of the rapidity with which the precipitate scattered and the effervescence due to the disengagement of gas. When the electrodes are pushed far enough apart to get rid of these difficulties, the resistance became so great that the current fell too low for the purpose in hand. I believe the precipitation takes place mainly, if not entirely, near the negative electrode. At all events, precipitation takes place *there* in some mixtures, and to this I will confine myself. It occurred to me even before making the experiment with straight tubes that the nascent hydrogen may react somehow on the salts present to cause precipitation, and I set myself to ascertain whether such was or was not the case. I made a mixture of dilute H_2SO_4 and $SrCl_2$ of such density that precipitation did not take place for about five minutes, and suspended in a portion of it a piece of zinc. Hydrogen was freely disengaged, and after two minutes the zinc was withdrawn, and when the effervescence subsided the state of the beaker in which the experiment was made was compared with a precisely similar beaker containing a portion of the same mixture, but without the zinc. At first I thought that the nascent hydrogen accelerated precipitation, but when purer zinc was used I was obliged, after repeated trials, to decide that such was not the case.

As far as I can see, the experiments I have been canvassing make dead against the "charge on the atom," but I think I can again strengthen my position by falling back upon the experiment of Prof. Lodge, already referred to. A ring of $BaSO_4$ is formed in the connecting tube. According to Helmholtz, the barium is first torn away from the chlorine by the current acting on the positive charge attached to it. It is then carried along by the current, and, since there is no chemical affinity, it cannot combine with the sulphion brought from the opposite electrode. They may pass one another closely, but the overwhelming influence of the current forbids combination—although combination would take place if the current ceased to pass. In a word, according to Hemholtz, Professor Lodge's ring could not be formed. The fact that it has been formed, points to the

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conclusion already arrived at—viz., that the strain of difference of potential is powerless against chemical affinity, although, as we have seen, under certain conditions it may turn the scale, deciding the fate of the molecule.

And have we not abundant proof of this in ordinary chemical reactions? Oil of turpentine is referred to by Helmholtz as being almost unaffected by the current; but, as is well known, chlorine gas decomposes it, forming HCl. Again, hydrochloric acid gas is decomposed by the metal sodium with formation of NaCl. I do not see how to avoid concluding, from these facts, that hydrogen holds the chlorine more firmly than it holds carbon; and, *à fortiori*, that chlorine holds the sodium with more force than it holds carbon in turpentine—yet a solution of sodic chloride is easily electrolysed. How is such a fact to be explained, except by supposing that the four ions in the solution of sodic chloride in water are in a state of unrest—of unstable equilibrium, and that the strain of E.M.F. turns the scale fracturing the molecule of NaCl?

The easy application of the idea of "the charge on the atom" to the doctrine of valency was undoubtedly the cause of its ready acceptation by chemists. Monads, dyads, &c., were talked of without anything very real underlying such terms, and what appeared to supply the void was eagerly taken up. "He (Helmholtz) tells us, as the results of the application of the modern theory of electricity to Faraday's great experimental law, that the atom of every chemical element is always united with a definite unvarying quantity of electricity. Moreover—and this is most important—that this definite amount of electricity attached to each atom stands in close relation with the combining power of the atom which modern chemistry terms quantivalence." (Speech of Sir H. Roscoe at the close of the Faraday Lecture.)

The creed at first sight looks very inviting, but it is strange that, if such be the real state of things, we ought not to be able, sooner or later, to get a glimpse of these all-pervading charges. There are many reactions, by means of which one would expect to detect them; but before examining such cases it is as well to ask what explanation the theory gives of the ordinary facts of chemistry, such as double decomposition? Potassium iodide and argentic nitrate react silver, iodide being precipitated. Has the theory ever been used to explain such a fact? It is clear that among the four atoms in question there is some "residual affinity" which causes the destruction of the original and the construction of the new molecules. But can anyone picture such "residual affinity" as a residual charge? If we attempt for a moment to figure an excess of positive electricity on the Ag of the $AgNO_3$, and an excess of negative in the iodine of the KI, it will be only for a moment, for the commonest facts rush in upon us, forbidding such a speculation.

Maxwell tried by the touchstone of contact-electricity to account for the atomic charges. "We know that if two metals are brought into contact at any point the rest of their surfaces will be electrified, and if the metals are in the form of two plates, separated by a narrow interval of air, the charge on each plate may become of considerable magnitude. Something like this may be supposed to occur when the two components of an electrolyte are in combination. Each pair of molecules may be supposed to touch at one point, and to have the rest of their surfaces charged with electricity due to the E.M.F. of contact. But to explain the phenomenon we ought to show why the charge thus produced on each molecule is of a fixed amount, and why, when a molecule of chlorine is combined with a molecule of zinc, the molecular charges are the same as when a molecule of chlorine is combined with a molecule of copper, *although* the E.M.F. between chlorine and zinc is much greater than that between chlorine and copper. If the charging of the molecules is the effect of the E.M.F. of contact, why should E.M.F.'s of different intensities produce exactly equal charges?" (*Electricity*, vol. i., p. 349).

It has often occurred to me that this objection might be met. The phenomenon of catalysis has gone hitherto without explanation. It is well known that SO_2 and oxygen do not combine under ordinary conditions, but if both gases be passed over spongy platinum, combination occurs, SO_3 being formed. Now if we assume that the contact of SO_2 with platinum charges it with electricity of one sign, and that contact of the metal with oxygen charges the latter with electricity of the opposite sign, the combination would be explained on the Helmholtz theory. We have, I believe, very good grounds for this speculation, for in the discussion on a paper, by Prof. Lodge, "On the Seat of the E.M.F. in a Voltaic Cell" (*Journal* of the Society of Telegraph-Engineers and Electricians, March, 1885), both sides, as I gather, agree that the contact of a gas with a metal may give rise to electrification. And although the E.M.F. between chlorine and zinc may be very different (as Maxwell says it is) from the E.M.F. between chlorine and copper, yet the opposite charges produces on each of these pairs of substances with a third or a fourth substance, such as water or air, present during the reaction may be equal. In this connection I cannot help referring to the importance Prof. Armstrong attaches to the presence during a reaction of other substances besides those which alone are supposed to take part in it (British Association paper in reply to Prof. Lodge). But when an attempt is made to apply the principle of contact-electricity to cases of displacement and double decomposition such as I have already given, one does not receive much encouragement. It is easy to conceive that the contact of a solution of argentic nitrate with potassic iodide may produce a difference of potential, but then both liquids conduct well and are mixed up, and how, under such circumstances, are we to suppose that mutually attracting charges can remain separate long enough to do any work? But let us ignore this difficulty, and suppose that contact of the molecules of $AgNO_3$ and KI produce charges which remain separate after the manner of the charges on pieces of zinc and copper, which are soldered together. Such charges must be equal and opposite, and according to Helmholtz the charges on the ions composing $AgNO_3$ and KI are also equal and opposite. Where, then, are the forces to cause fracture of the molecules of $AgNO_3$ and KI?

The explanation which I have given—as I conceive—of catalysis on the Helmholtz theory has from time to time appeared to me so suggestive that I have often recurred to it in the hope of explaining common chemical facts by the same mode of reasoning. Chlorine displaces iodine from potassium iodide. Suppose the chlorine becomes charged with the regulation monad quantity of negative electricity when itself or the water containing it in solution comes into contact with the solution of KI. This, according to theory, is no more than what the atom of iodine is postulated to possess, and by virtue of which it is bound to the potassium. Why, then, should the iodine be ousted? Possession is nine points of the law. Again, suppose that chlorine has got, by the contact just alluded to, a greater charge than the monad quantity, then there must be an equal charge of the opposite kind in close proximity to it; and it appears inconceivable that these charges should not, in a conducting liquid, at once combine and neutralise each other, instead of acting on the smaller charges already occupied in holding the atoms of KI together. Moreover, if any electrification of this kind really took place, we ought to be able to detect it by the electrometer. I have made many experiments with this object and refer to *Nature* (Aug. 18th, 1887), where I have described some of them. No electrification could be detected as accompanying or as a result of reactions, *when nothing escaped from the vessel in which they were allowed to go on.* I have found, however, that when gases escape electrification, as a rule, occurs; but as I believe I have proved that such electrifications are independent of the reactions, I shall not discuss them here.

(To be continued.)

ASTONISHED THE LIGHTNING.—A storm broke over the hills at a little place in the West of America, and the lightning took it into its head to strike for a small and lonely hut, where not much harm looked likely to be done. Judging from reports afterwards received, the lightning was considerably astonished to find that over a million pounds of giant blasting powder were stored under that hut.

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THE SOLUTION OF THE MUNICIPAL RAPID TRANSIT PROBLEM.*

BY FRANK J. SPRAGUE.

(Continued from page 105.)

The narrow streets, their hilly character, and the lack of paving, especially in the new districts, has made the road one of exceptional difficulty to operate. There are no less than 29 curves, requiring bent rails, the majority being of sharp radius, five being less than 30ft. There are also several sweeps or curves of large radius, several turnouts and cross-overs. The grades are the maximum ever ascended in practice by a self-propelled car depending on track adhesion alone, and many of these grades are very long. Going east there is one section of almost continual ascent for about 5,600ft. with grades varying from three to seven per cent., and going west there is a stretch of 1,900ft. with grades varying from three to ten per cent.

When we first undertook to equip this road in the face of these difficulties, there was the additional discouragement of the ridicule of a great many prominent street railway men and car constructors, as well as electricians. It was only a comparatively short time ago that one of the leading lights in street railway circles made a report to the street railway convention in which he stated that unless some new invention should be made it would be impossible for any self-propelled vehicle to satisfactorily operate under the ordinary condition of street-car service. He, as others, held that the grades and curves met in practice were so severe and the condition of the track so bad that a car propelled by its own wheels could not, under any possibility, day in and day out, be relied upon to move itself. One electrician even made the statement only a short time ago that any man who should attempt to operate on more than a 6 per cent. grade would lose his reputation.

Reliability, economy, simplicity of construction and operation on a scale never before attempted, and under conditions which we could not foresee—this was the problem, and, perhaps, it was well we did not know the difficulties. Then, again, while there have been strong friends of the enterprise in Richmond itself, there was a class that felt anything but pleasure at a stranger's advent.

The change of feeling with which this enterprise has been regarded by this doubting element is somewhat significant. When the franchise was originally secured the city was blest by one car line only, and this had dingy bobtail cars drawn by mules, which, on the heavy grades characterising the topography of Richmond, made very slow time. The new districts were not reached at all. When the present line was proposed there were not wanting philosophers who knew that no road would be operated. Even when the tracks were down these same wiseacres predicted that no cars would ever move over them, and most certainly if they did, the time-honoured mule would be called upon for duty. Even after the cars were put on the line experimentally there existed but little faith that success would be reached. But times have changed. The mules of the competing line are to give way to electricity. The citizens of Richmond are the strongest friends of the electric railroad of to-day, and as regards the street railway community elsewhere, the work which the road has done and is doing and the acceptance of the contract speak for themselves.

The difficulties we have met are many. One of the most annoying at first experienced was that the cars frequently jumped the tracks. A large portion of the track was, as has been stated, laid in macadam and dirt roads, the latter being chiefly in new districts and in a soil of which the chief component was red or yellow clay; and although the curves were of sharp radius, only one guard rail was used, and they were not bound in by paving. The winter months brought frequent and heavy rains. The tracks were found to be settling out of sight in mud, and especially at the curves they were spreading. The cars being large and heavy, with a 4ft. 8½in. gauge, and a 6ft. wheel base, helped to make the curves spread by the tangential pressure of the forward wheels on the outer rails. Mud and stones would get into the grooves, and the cars having a tendency to go ahead instead of being pulled around by the head, as with horses, would climb the track, and, before an inexperienced man could check them, the wheels were down 5in. in the mud alongside the stringer pieces, and the track brakes hard and fast against the tracks. Sometimes it required lifting, sometimes prying, and sometimes a heavy, hard pull on the part of the motors to get them back again. Experience, however, is a great teacher, and among other things which has been taught is this: that money will be saved by a good track construction and the observance of a few practical points All curves should be bound in and paved, and this has since been done in Richmond. They should likewise have two guard rails, because it is much easier to steer a car by its rear wheels by holding them in place than by allowing them to crowd the inner rail and force the forward wheels to climb the outer one. In dry weather, with the large wheel base and sharp curve, it is found advisable to grease the grooved rails.

Another point which has to be carefully taken care of is the character of switch which is put in for sidings and cross-overs. If drop switches are used, they should be of such character as to allow the car to come down easily. Tongue switches are now being put in on all the new work which is being done. It is a rare thing at present to have a car leave the track. I have seen a car in the winter propelled for 100ft. off the track, and also leave and go back on its own account.

The power-house is situated two blocks away from the nearest point of the line, and is almost equidistant from its extremities. As a distributing point, it is, therefore, both theoretically and practically a central station. In the construction no expense has been spared, and the performance of the station has justified it. The battery consists of three cylindrical return tubular boilers of the latest pattern, mounted on a Jarvis patent furnace, their capacity being 125 h.p. each. The water is taken from the city mains or from a well. All feed-water connections are of brass pipe. From the pumps the water passes first through the feed water heater, where it is heated to from 150 to 200degs. Fah. From there it goes to the filter. The draught in the furnace is regulated by an automatic steam damper regulator which, with anything like regular firing, keeps a pressure within two pounds of that for which the regulator is set.

The boilers all feed into one main feed steam-pipe, which in turn leads to a separator, a large iron cylinder into which the steam passes, the water falling to the bottom and the dry steam being carried off at the top. All live steam-pipes in the boiler-room are covered with magnesia.

The present battery occupies less than half the available space in the boiler-room, so that four more boilers can easily be put up when it becomes necessary to enlarge the plant. Two more have just been added. An important feature of these boilers, which are the source of power of the whole system, should not be overlooked, that is, the quality of coal burned. Where a very perfect combustion is obtained a grade of coal can be used which would be impracticable in an ordinary furnace; the mixture at present being used is two parts screenings to one part bituminous, costing from 1dol. 75 cents to 2dols. per tons delivered. As the station is only three hundred feet distant from the depots of three railroads, coal can be obtained almost at the door. From the boiler-room, both the steam and exhaust pipes run in an underground, mineral-wool packed trench to the engine-room.

The railroad engines, of which there are at present three, are of the Armington and Sims' high-speed type, and develop when running at full load 125 h.p. each at 250 revolutions.

Each engine drives two special Edison dynamos of 40,000 watts capacity each, wound for 500 volts maximum pressure. The dynamos feed into copper "bus" bars supported on the walls by porcelain insulators.

Each machine has its independent ampere-meter, and in addition there is a general ampere-meter at the end of the positive "bus" bar. From this bar the current passes to four snap switches, each switch being connected through a three-plug safety switch block to one of the feeders supply-

* Read before the American Institute of Electrical Engineers, June 19th, 1888

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ing current to the main line wire. These four feeder wires tap into the line wire at different points, thus maintaining the pressure approximately equal all along the line. At the ends of one of the feeders in the central station pressure indicators are to be attached, which will indicate the voltage at the junction of one of these feeders with the main current wire, and this will serve as a guide.

The electric circuit consists of two parts—the overhead and the ground circuit, each being of compound character. Along the kerbstones at distances of 125ft. are 30ft. poles, inserted into the ground a distance of 5ft. Great difficulty was experienced at first on account of the clayey character of the soil, and it became necessary at the corners to put in very heavy poles, which were embedded in concrete and stones to prevent settling out of place after heavy rains. These poles carry the main circuit which extends throughout the entire length of the road, and is a copper wire three-sixteenths of an inch in diameter; this is called the main conductor, for on it depends the operation of the road in case of accidents or repairs to the contact wire.

The arrangement of main and working conductor are as already set forth.

This main conductor is, as stated, supplied at widely-separated points by feeders, which come from the main supply at the central station. Without the use of these feeders, which can also be reinforced if necessary, the size and cost of the overhead conductors would be very largely increased. The curves are formed of a series of short chords, which approximate the central line of curvature.

The current is taken from this working conductor by a light structure on top of the car. This consists of a low skeleton framework which carries an adjustable swivelling trunnion, having at its upper end a jaw in which is suspended a counter-balanced trolley-pole, having at its extension a grooved wheel held by a spring against, and making running flexible contact with, the under side of the working conductor. The flexibility of this arrangement is very great, it being able to follow with perfect facility variations of the trolley wire two or three feet in either horizontal or vertical direction, at any speed, and around any curve. What is all important, it relieves the line of strain instead of adding to it. When getting at the end of the track, this trolley trunnion is swung around so as trend in a proper direction abaft the centre of the car. If off the line, it can be replaced from the car quickly and easily in the darkest night. From the trolley the current passes through a protected wire to the lightning arrester, and thence to two switches, one at each end of the car, whence, after whatever commutation is necessary, it goes to the motor circuits, and thence to the wheel frame.

The return circuit is through the track, and thence by both metallic and ground circuits to the station. Each section of rail is joined to a copper ground wire, which runs throughout the length of the road underneath or alongside the stringer pieces, which is done to prevent appreciable differences of potential existing between the rails. As a further precaution, at intervals of 500ft. this ground wire is connected to an earth plate, and at seven points widely distributed. These ground plates are supplemented by heavy iron pipes sunk into iron ore, or 12in. water wells, about 25ft. deep. The ground wire is connected to the station, and there is also a main ground connection made there in a 30ft. well through a large zinc plate, and another to the entire water works system. Some modifications of the overhead system are now being made which will make it impossible for any accident to one section of the line to disable the remainder; will enable the different sections to be operated independently; and, in case of a fire which may necessitate the blocking or temporary disabling of one part of the line, will allow this section of the line to be cut out of action either automatically or at will.

Each car is fitted with a duplicate and very powerful motor equipment. This is carried entirely beneath the car body, is very compact, out of sight, and necessitates no radical change in the construction of the car. The body had to be stiffened a little and 3in. steel axles put in. One of the great objections which have been met with in applying motors, whether steam, electrical, or of any other character, to the propulsion of street railways, has been the difficulty of getting sufficient track adhesion to operate the car under all conditions of track, loads, and grades. Especially was this objection true in Richmond, where it was manifest that no application of a motor system could be fully successful unless the entire weight of the car and its contents was made available for traction.

One of the manifest reasons is, of course, the slippery character of the track under many conditions. Another thing should also be noted, and that is that it is almost impossible in practice to cast all wheels of exactly the same circumference, or at least so that the paths described by the lines of contact shall be the same. Moreover, on curves the wheels are all travelling over paths of different lengths. Theoretically, the wheels should be independently driven, but since this is not possible, it follows that the next best thing is to drive each pair of wheels independently. It is a fact which admits of no dispute that there are conditions of track which will not permit of a car being driven from one pair of wheels only, and this difficulty is often augmented by the fact that if one pair of wheels only is used they will sometimes be leading, sometimes following; on heavy grades, with one platform reserved for the driver, there is a very serious displacement of the centre of gravity, and there may be very much more weight upon one pair of wheels than on the other. The whole experience in Richmond has been to emphasise the value and necessity of independently driven axles.

To accomplish this, one motor is centred upon each axle, and to allow the required freedom of motion, and at the same time to preserve perfect parallelism in the meshing of the gears, and also for taking part of the weight of the motor off the body of the axle and to throw it on to the journals, one end of the motor is supported by double compression springs playing upon a loosely suspended bolt, which is supported from a cross girder in the bottom of the car.

The motors are, then, so to speak, weighed or flexibly supported from the car body, and the motion of the armatures is transmitted to the axles through intermediate gearing, of compact form and great strength, so that whenever the axles are in motion, there is a spring touch of the pinions upon the gears. Barring friction, a single pound pressure exerted in either direction would lift or depress the motor a slight amount, and no matter how sudden the strain, whether because of a variation of load or speed, or a reversal of direction of rotation, it is impossible to strip the gears unless the steady strain exceeds the strength of the iron, the pressure on the gears always being a progressive one. The motor armature makes nearly twelve revolutions to each revolution of the car axle.

The motors, although in one sense independent, are connected with duplicate switches at either end of the car, which afford simultaneous control of both machines. These motors, which are of normal capacity of 7½ h.p. each, can for a short time work up to 30 h.p., and are capable of producing a tractive effort of over 3,000 lbs. at 50 per cent. efficiency.

The machines are controlled by a single movement switch, which effects the various commutations and reversals. They run with fixed brushes in both directions, and under all loads. They are run without any covering, and I have no doubt of having street car motors in such condition soon that the cars will be run over a pit, and the machines washed down with a hose.

The cars can be run at widely different speeds, varying from the slowest crawl to twelve or more miles per hour. They can be started and stopped without the use of brakes in the space of three or four inches, and when making the normal running speed can, in an emergency, be stopped and reversed without brakes within less than a quarter of a car length. The starting, although prompt, is easy, and without shock or jar.

Emergencies sometimes bring out qualities of motors which are unexpected, or which, at least, if counted on are rarely ever brought into play. On one occasion a man was decending a 6 per cent. grade with a heavy load when his brake chain parted. Seeing a sharp curve right ahead of him, which he knew he would leave if he struck it at the speed he was running, he instantly reversed his machines and brought his car to a standstill, and on the rest of his

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trip handled his machines entirely with the motors. On another occasion a man, passing from behind one car directly in front of another, was struck and knocked down by the dash-board. Although the car was moving at a lively gait, the machines were reversed and the wheels stopped within a foot of the man. By any other method

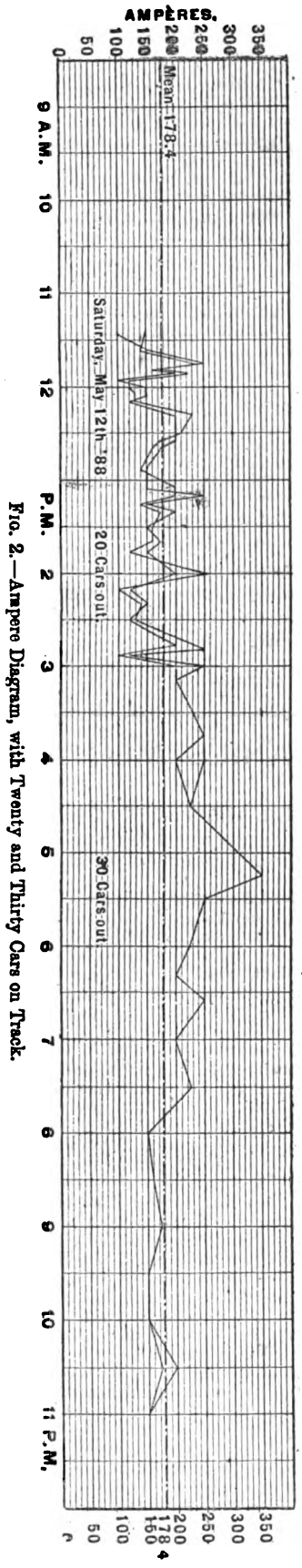

Fig. 2.—Ampere Diagram, with Twenty and Thirty Cars on Track.

of propulsion he would have been killed. Frequently on a 10 per cent. grade, with a loaded car, the brakes have been thrown off, the machines reversed, the car stopped and started backward up hill within less than one-half of its length, a test of the most remarkable severity.

In noting the control of the car, one is struck at the remarkable character of the traction, and cannot help wondering where it comes from; unquestionably it is in a large measure due to the fact that every pound of weight is available for traction, and that the two axles, being independently driven, can take their own speed, and each pair get the best grip.

Another thing to be noted, where the ground circuit is

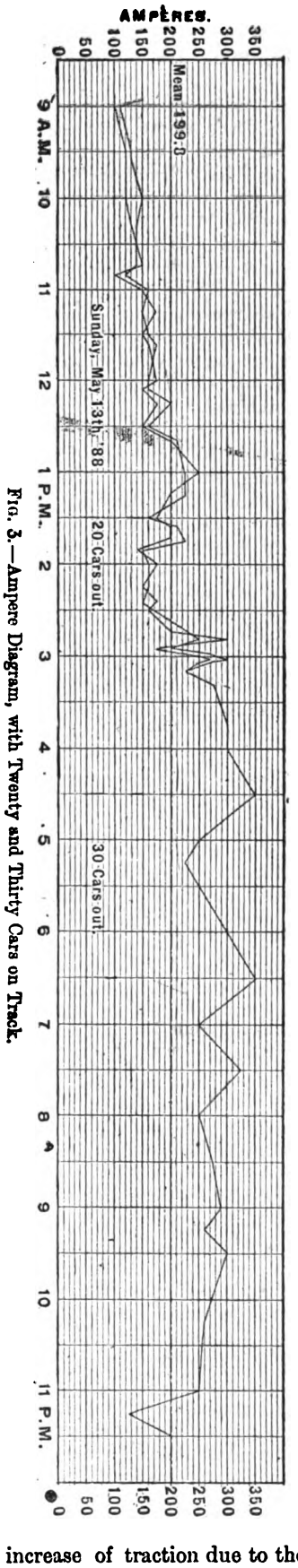

Fig. 3.—Ampere Diagram, with Twenty and Thirty Cars on Track.

used, is the increase of traction due to the passage of the current from the wheels into the rails. Exactly what molecular action takes place has not been ascertained. It may be simply heating at the contact surface; but the fact remains that the traction is very largely increased. The magnetic condition of the wheels and tracks also has some function in this increase of traction. The wheels and axles

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are magnetised by the method of motor construction and mounting, and also by the passage of the current through them. The tracks are likewise magnetised by the current passing through them, and also by the rolling contact of the wheels. Yet, admitting all these aids, the results have been extraordinary.

Sixteen-foot closed cars carrying picked loads of fifty-five to sixty passengers, and having a total weight of 15,000 lbs., are operated on the 10 per cent. grade, often with a slippery and slimy rail, and on 27ft. curves, without the use of sand or extra help.

These same grades and curves have been ascended without sand after one of the worst sleet storms which has visited this section for years. Various tests under the most unfavourable conditions have been made, cars often being required to cut their way through clay, snow, and ice when the tracks were out of sight. No severer test could have been made, and the power and tractive effort developed have exceeded the most sanguine expectations.

Cars have often been stopped and started on the heaviest grades, and in the sharpest curves. One motor has propelled two cars around sharp curves and up six per cent. grades. One car has pushed another of greater weight around the sharpest curves and up seven and eight per cent. grades both straight and combined.

I have no hesitation in saying that with a clean track, and with proper gearing, these cars could mount a 15 per cent. grade, depending on adhesion alone. During the four months' operation, although there have been troubles and changes have been made while the cars were running commercially, no car has been pulled a foot by animal power; if any accident has occurred to a motor the car has gone along with one machine, oftentimes with heavy loads and on heavy grades, or in some cases has gone home in company with another car. One hundred and forty men who did not know the difference between a motor and a hand saw have been broken in to handling these cars, oftentimes with remarkably short training. Up to Saturday, May 4, the number of regular cars on duty had not exceeded twenty. On that day at 4 p.m., the hour when traffic becomes exceptionally heavy, we began putting out ten open cars, starting them from the eastern car house alternating with the closed cars, but finally banking them all up at the Old Reservoir. At 6 p.m. they were started home, and shortly afterwards these 10 open cars, headed by a closed car, were all run at full speed close together down the east-bound track of Clay-street. At one time 14 cars were on the line between Clay and Hancock streets and the Old Reservoir, and shortly before 7 o'clock there were about 22 cars on the line between Capitol-square and the Old Reservoir, and at 7 o'clock 30 cars were on the line, the closed cars being very heavily loaded, many of the cars being run with two minute intervals. The three boilers, whose capacity is 375 h.p., were then supplying three Armington and Sims' engines of 125 h.p. capacity, which were driving the six railroad dynamos, and two Westinghouse engines of 110 h.p. capacity, which were driving two alternating current dynamos and exciters, with an equivalent load of 1,060 incandescent lamps. The mixture was enriched and the firing of boilers became pretty active, there being, in addition to the 30 cars badly banked, about 110 h.p. taken for lighting.

The highest reading, however, on the line was less than three-quarters of the normal capacity of the dynamos, which were originally intended only for 30 cars, and the average reading for this number was only a trifle over half the normal capacity.

The ampere readings taken at intervals of ten and fifteen minutes give a load diagram which is really higher than a continuously recording instrument would show. Figs. 2 and 3 show the ampere readings with twenty and thirty cars.

The figures which follow, being based upon an actual service increasing from eight to thirty cars, and extending over a period of four months under the most trying circumstances, and at the most critical and care-requiring period of the enterprise's existence, will give street railway men the most careful and liberal estimate of every possible expense attending the operation of the road which is in any way dependent upon its electrical features. The operating expenses are given under two heads; first, the central station operating expenses, and second, the road operating expenses, the two constituting the total cost of motive power. These are given in detail, and they will probably be found to cover every expense, although in some small ways the distribution of these expenses may be found to be changed by several months' longer running. The fuel and other incidental expenses of the station are from the engineer's record, and checked by the readings of the electrical instruments.

For thirty cars running on a double track the central station expenses are about as follows:

52 42-100 cwt. coal at 10 cents	$5.84	
113 70-100 cwt. screenings at 7 cents	7.96	
5 pints cylinder oil, at 75 cents per gallon	.47	
5 pints dynamo oil, at 30 cents per gallon	.18	
3 pounds waste, at 10 cents	.30	
Water at current rates	3.00	
Fuel, &c.		$17.75
1 day engineer	$3.00	
1 night engineer	2.25	
4 firemen	6.00	
1 cleaner	1.50	
2 dynamo men	3.50	
1 electrician	4.00	
Labour		$20.25
Lighting		.50
Depreciation and repairs on dynamos, 3 per cent.		1.50
Depreciation and repairs on engine and boilers, 10 per cent.		4.38
Total central station expenses		$44.38

Or $1.48 per car making eighty miles.

[The central station being operated for twenty-four hours for lighting and power purposes, the lighting company has now assumed charge, and rents the power to the cars at 1 dol. 60 cents per day.]

(To be continued.)

COMPANIES' MEETINGS.

NATIONAL TELEPHONE COMPANY.

The eighth annual meeting of the National Telephone Company took place on Saturday at the offices of the Company, 162a, Queen Victoria-street, E.C.

Colonel R. Raynsford Jackson (Chairman of the Company) presided, and said: Gentlemen, the report contains within itself all that is necessary for you to know of the affairs of the Company. You will see that the gross revenue reached on June 30 last was £109,572. 12s. 7d., and that the increase for the year was £17,235. 10s. 3d. I will ask your attention to the abstract of accounts; there you will see that the first three columns are headed differently to the heading used in former abstracts. The heading in those was "gross revenue"; that was to a certain extent misleading, because some people thought it meant the gross revenue entered in the accounts for the year, whereas it is the revenue reached by June 30; and it is divided in the present abstract into two headings—annual rentals and sundries, and fee messages. You will see that the fee message revenue is steadily growing, and I thought it would be interesting to you to watch the development of this source of profit. The trunk pole lines are now 842 miles, an increase of 199 miles since last year; and the wire they carry is now 2,509 miles, an increase of 590 since last year. There is also an increase of 26 in the number of exchanges, and of 1,470 in the number of lines, the present number of lines being 9,324. I now call your attention to the list of our centres on the second page. You will see the large number of towns that are grouped together and have communication with each other through the instrumentality of the trunk system. By next year we shall have a considerable increase in the number of towns so connected, and by the middle of September Sheffield and Birmingham will be in telephonic connection, which will combine the Midland district with Nottingham and carry a trunk line from Birmingham through the Potteries to the frontier of the Lancashire and Cheshire Company's system, and they will meet us there. We shall then have trunk communication in almost a straight line from Birmingham to Manchester and the whole Lancashire system. This will give us the advantage, when London and Birmingham are telephonically connected, of a short connection between Manchester and London. London also will be connected with Nottingham and Yorkshire through Birmingham. I now call your attention to one feature in the capital account, that is that £70,700 out of £75,000 debenture bonds have been converted into debenture stock. £60,900 of the debenture bonds were at 6 per cent. interest and £14,100 at 5 per cent. The debenture stock has been issued at 4½ per cent., thus greatly diminishing the interest account. I wish now to call your attention to the position we occupied before Nov. 29, 1884, and if you will look at the map you will see the boundary of our districts marked in red. You will see in red several small spots. These represent telephonic oases in a huge barren district, for they were the only areas in which

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we were allowed to exploit the telephone. We were not allowed to connect town and town; and had the system then in vogue continued, it would have been utterly impossible to make the progress which I have described to-day, and to cover the country with exchanges and trunk wires. Mr. Fawcett, a liberal and large-minded statesman, presided over the Post Office, and he, in the interest of the public, gave us new licenses, enabling the lines in all directions to connect town and town, and rendered possible the development at which we have arrived to-day. Had it not been for this, the position of the telephone in this country, which leads the van in enterprise, would have been absolutely disgraceful. With reference to amalgamation, I have only to confirm the words used by Mr. Brand when addressing his shareholders. He mentions as one of the difficulties in the way of amalgamation the difference of opinion that may arise as to the valuation of the prospects of future development. I do not think that when fair-minded men approach each other with a view to obtaining a given result difficulties are allowed permanently to stand in the way—the means are generally found to overcome them; but I will say this much, as regards the National Telephone Company, that we shall have to be specially guarded against giving capital for prospective improvement in other companies, the dividends upon which may have to be paid out of the solid earnings of the National Telephone Company. I do apprehend, however, that the necessity of taking care of ourselves upon this point will stand in the way or be an important factor in our negotiations. It may not be unimportant, when we are so much in contact with a great public department as we are with the Post Office, that it should be known to our shareholders that our relations with that department continue to be of the same friendly character as hitherto. The Chairman concluded by moving the adoption of the report.

Colonel Harrison seconded the motion, and it was carried unanimously.

On the motion of the **Chairman**, the meeting approved a dividend upon the ordinary capital for the second half of the year at the rate of 5 per cent. per annum, allowing for £2,500 to be placed to the reserve fund, and £3,253. 5s. 1d. to be carried forward.

The **Chairman** moved the re-election of Mr. John Bruce, of Edinburgh, as a director, and the motion was seconded by Mr. Sands, and carried unanimously.

On the motion of the **Chairman**, seconded by **Colonel Williams**, the re-election of Mr. Jeremiah Garnet, of Manchester, to the Board was similarly carried.

A vote of thanks to the Chairman, Directors, and Secretary, moved by Mr. Dixon, concluded the meeting.

NEW COMPANIES REGISTERED.

Monte Video Telephone Company.—The English Bank of the River Plate invite subscriptions for £180,000 of share capital, divided in 24,000 six per cent. preference and 12,000 ordinary shares of £5 each, of the Monte Video Telephone Company, Limited, which has been formed to acquire as a going concern the concession, rights, patent privileges, plant, exchanges, and other property belonging to the telephone company known as La Sociedad Anonima Compania Telefonica La Uruguaya, in the city of Monte Video. The Uruguay Company was incorporated in the month of April, 1885. It commenced operations with about 450 subscribers, since which it has made rapid progress, and by the latest information received from Monte Video, the total number of telephones now working are 1,610. A telegram from Monte Video states that the net receipts for the first four months of the Uruguay Company's current year ending 30th June last were 18,800dols., or at the rate of 56,400dols. per annum, equivalent to £12,000. The Directors of this Company are:

Arthur Holland, Esq., 2, East India-avenue, E.C., director of North-Western of Uruguay Railway Company, Limited.

Thomas D. Peters, Esq., late of Messrs. Peters and Hall, Buenos Ayres.

Edward F. Powers, Esq., late managing director of the River Plate Telephone and Electric Light Company, Limited, who will join the Board after allotment.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company for the past week amounted to £5,601.

Direct United States Cable Company.—The Direct United States Cable Company, Limited, state that their main cable between Ireland and Halifax (Nova Scotia) is now in efficient working order.

Eastern Telegraph Company.—The Eastern Telegraph Company's traffic receipts for the month of July, 1888, amounted to £48,735, and to £45,805 in the corresponding period of 1887.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The traffic receipts of the Eastern Extension, Australasia, and China Telegraph Company, Limited, for the month of July, 1888, amounted to £35,233, and to £38,520 in the corresponding period of 1887.

Commercial Cable Company.—A circular has been distributed by this Company to the effect that on and after the 1st September, 1888, and until further notice, the charge for the transmission of telegrams, "via Commercial," between Great Britain and Ireland and the city of New York, Brooklyn, and New England States, the provinces of Quebec and Ontario, Newfoundland, St. Pierre, Prince Edward Island, Nova Scotia, and New Brunswick will be 1s. per word.

Maxim-Weston Electric Company.—Mr. Hugh Watt, M.P., has resigned his position of director and managing-director of the Maxim-Weston Electric Company, Limited. The engagement of Mr. J. Wright as secretary has been terminated by the Board, and Mr. Samuel J. Boyce (of the firm of Messrs. Boyce and Ramsay, chartered accountants) has been appointed secretary. The offices of the Company have been removed to No. 2, Metal Exchange-buildings, 95-97, Gracechurch-street, E.C.

Companies of the Month.—The following companies have been registered during the past month:—

Crompton and Co., £5 shares	£140,000
City of Westminster Electrical Syndicate, £1 shares	10,000
East Strand and District Electric and Power Company, £5 shares	5,000
Monte Video Telephone Company, £5 shares	180,000
Submarine Mining and Torpedo Explosives Company, £1 shares	30,000
Woodite Company, £10 shares	50,000

PROVISIONAL PATENTS, 1888.

JULY 27.

10,875. **An improved surgical apparatus for electro massage.** William George Johnson, 9 and 10, Southampton-buildings, Holborn.

10,887. **Improvements in electric cartridges and primers.** Selden Allen Day, 169, Fleet-street, London. [Date applied for under Section 103 of the Patents, &c., Act, 1883, 23rd March, 1888.]

10,890. **Improvements in motors.** William Wynne, 142, Fleet-street, London. (Joseph Beduwé, Belgium.)

10,900. **An improved electric alarm for varying levels and pressures.** Andrew Siegmann, Gray's Inn Chambers, 20, High Holborn, London, W.C.

JULY 28.

10,904. **Improvements in electric batteries.** R. Sauerwald, 45, Southampton-buildings, London.

10,929. **Improvements in magneto-electric generators and appliances for use in connection therewith.** Edward Cox-Walker and Alan Archibald Campbell Swinton, 75, Queen Victoria-street, London, E.C.

10,941. **Improvements in the arrangements for the lighting of railway trains by electricity.** Illius Augustus Timmis, 2, Great George-street, Westminster, S.W.

10,945. **An improved cut-out for electric circuits.** William Hopkin Akester and George Hopkins, 57, Chancery-lane, London.

10,952. **Improvements in dynamo-electric machines.** Lazarus Simon Magnus Pyke and Harry Theodore Barnett, 433, Strand, London, W.C.

10,954. **Improvements in or connected with dynamo-electric machines.** Ernest Heinrich Geist, 433, Strand, London. (Complete specification.)

10,956. **An electrical lighting apparatus for medical and surgical purposes.** Castle Smith, 54, Fleet-street, London. (R. Blaensdorf, Nachfolger, Frankfort-on-Maine.)

JULY 30.

10,980. **Improvements in internal combustion thermo-motors.** James Hargreaves, 4, Clayton-square, Liverpool.

10,982. **Improvements in electric battery cells and combinations of same for electric lighting, power, signalling purposes, firing torpedoes, &c.** Thomas Pease, 32, Holborn hill, Higher Tranmere, Birkenhead.

11,019. **Improvements in electric bells.** Walker Moseley, 82, Montpelier-road, Peckham.

11,020. **Improvements in the method of producing aluminium chloride.** Camille Alphonse Faure, 24, Southampton-buildings, Chancery-lane, London, W.C. [Date applied for under Section 103 of the Patents, &c., Act, 1883, 6th March, 1888.]

JULY 31.

11,050. **The cure of toothache by voltaic couple.** Joseph Parkinson, Samuel Fawcett, and Charles Frederick Parkinson, 30, South Regent-street, Lancaster.

11,065. **Improvements in or relating to apparatus for regulating the brilliancy at which lamps included in the secondary circuits of induction coils or electric converters may be caused to burn.** William Phillips Thompson, 6, Lord-street, Liverpool. (George Westinghouse, jun., United States.) (Complete specification.)

11,082. **An improved mode of an apparatus for transmitting electrically autographic messages, signs, and markings.** Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, Middlesex. (Elisha Gray, United States.) (Complete specification.)

11,100. **Improvements in permanent way for vehicles propelled by electricity.** Joseph Kincaird, 47, Lincoln's-inn-fields, London.

11,106. **Improvements in electrical signalling apparatus.** Henry Harris Lake, 45, Southampton-buildings, London. (Edward Davis and Ebenezer Baker Welch, United States.)

11,108. **Improvements in electric conductors or cables, and in means for preventing disruptive discharges therefrom.** Philip Middleton Justice, 55 and 56, Chancery-lane, Middlesex. (Edward G. Acheson, United States.) (Complete specification.)

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AUGUST 1.

11,147. **Improvements in the means or apparatus for transmitting and receiving, and for recording and reproducing speech or sounds.** Leon Le Pontois, 169, Fleet-street, London.

AUGUST 2.

11,174. **Improvements in and connected with the method of and apparatus for electrically lighting railway trains.** Thomas Parker, of the firm of Elwell-Parker (Limited), 70, Market-street, Manchester.

11,182. **Motive power for driving electric and other machinery.** Francis Stradwick Harwood, Leicester House, Cromer, Norfolk, and Henry George Cheesman, Winterton, Doncaster, Lincolnshire.

11,184. **Improvements relating to electric arc lamps.** Francis Teague and Frederick Ernest Teague, Crown-yard, Stanhope-street, N.W.

COMPLETE SPECIFICATIONS ACCEPTED.

AUGUST 2, 1887.

10,663. **Improvements in or relating to electrical type-writers and printing telegraphs.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James F. McLaughlin, United States.)

AUGUST 5, 1887.

10,785. **Improvements in clocks and apparatus for winding the same by electricity.** James Grieve Lorrain, Norfolk House, Norfolk-street, London, W.C.

AUGUST 6, 1887.

10,836. **Improvements in electrical firing mechanism for ordnance.** Charles Ambrose McEvoy, London, Ordnance Works, Bear-lane, Southwark, Surrey.

SEPTEMBER 2, 1887.

11,928. **Improvements in apparatus for indicating the presence of fire-damp in coal mines or other places.** Joseph Wilson Swan, 47, Lincoln's-inn-fields, London.

SEPTEMBER 22, 1887.

12,880. **Improved method of producing solid metal sheets by electro-deposition suitable for compass cards, stencils, and open worked flat or curved articles for decorative and other uses.** Wallace John Reynolds, 166, Fleet-street, London.

OCTOBER 10, 1887.

13,709. **Indiarubber compensators for telegraph signal and other wires.** Robert Sebastian Bozon, 144, Kennington-road, Lambeth, London, S.E.

MARCH 27, 1888.

4659. **Improvements in apparatus for making and breaking electrical circuits in connection with call or alarm boxes, and recording the same automatically on dials.** Fredk. Thomas Schmidt, Sunbridge Chambers, Bradford, Yorkshire.

MAY 29, 1888.

7848. **Improvements in or relating to indicators for alternating electric currents.** William Phillips Thompson, 6, Lord-street, Liverpool. (George Westinghouse, jun., United States.)

7849. **Improvements in or relating to apparatus for detecting and locating faults in alternate current electric circuits.** William Phillips Thompson, 6, Lord-street, Liverpool. (George Westinghouse, jun., United States.)

MAY 31, 1888.

7998. **Improvements in and relating to shades and reflectors for incandescent electric lamps.** Frank Holman, 45, Southampton-buildings, London.

JUNE 23, 1888.

9206. **Improvements in galvanic elements or batteries.** Carl Lütcke and Paul George, 166, Fleet-street, London.

JUNE 26, 1888.

9331. **Improvements in relays.** Frederick Stitzel and Charles Weinedel, 18, Buckingham-street, Strand, London, Middlesex.

JULY 3, 1888.

9660. **Improvements in electric motors and dynamo machines.** Alfred Julius Boult, 323, High Holborn, Middlesex. (Orazie Lugo, United States.)

9661. **Improvements in telephone transmitters.** Alfred Julius Boult, 323, High Holborn, Middlesex. (Julius Emner, jun., United States.)

SPECIFICATIONS PUBLISHED.

1887.

4533. **Electric locomotives and vehicles.** M. R. Ward. 8d.
9235. **Miners' safety lamps.** J. Treherne. 8d.
10,767. **Instruments for measuring electric currents, &c.** W. Lowrie. 11d.
11,751. **Electrical signalling apparatus for railways.** A. E. Nicoll. 8d.
11,932. **Electrical conducting cables.** C. D. Abel. (Siemens and Halske.) 11d.
11,950. **Electrical telephones.** J. S. Ross and H. Baines. 4d.
16,554. **Electric apparatus for indicating distant water level, &c.** G. Binter. 8d.

1888.

1128. **Galvanic Batteries.** A. A. Fortin. 11d.
1968. **Secondary battery.** W. Tilley. 8d.
4456. **Administering galvanic currents for curative purposes.** A. Collingridge. 6d.
5731. **Measuring electric currents, &c.** H. H. Lake. (Thomson.) 1s. 1d.
5732. **Measuring electric currents, &c.** H. H. Lake. (Thomson.) 8d.
6157. **Electric arc lamps.** R. E. Keen. 6d.
7541. **Dynamo electric generators.** W. P. Thompson. (Spang.) 8d.
7551. **Electrical coupling devices, &c.** J. Kendall and O. Cooper. 8d.
7850. **Alternate current electric distribution.** W. P. Thompson. (Westinghouse). 8d.
7977. **Filling secondary battery plates.** H. G. Morris and G. P. Salom. 6d.
8171. **Magneto-electric liquid level indicators.** J. J. Ghegan. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday.
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	3¼
12 Feb.	2/0	— fully paid	5	4¼
26 April	1%	Anglo-American	100	41⅛
26 April	2%	— Pref.	100	69
12 Feb., 85	5/0	— Def.	100	14½
28 June	3/0	Brazilian Submarine	10	13
14 June	1/0	Con Telephone & Main	1	¾x
15 Feb.	8/0	Cuba	10	13¾
28 July	10/0	— 10% Pref.	10	18¾
28 Mar.	2/2½	Direct Spanish	9	4
28 Mar.	5/0	— 10% Pref.	10	10
28 Mar.	2/0	Direct United States	20	9½
12 April	2/6	Eastern	10	12⅝
12 April	3/0	— 6% Pref.	10	14¾
1 Feb.	5%	— 5%, 1899	100	111
26 April	4%	— 4% Deb. Stock	100	106½
12 July	2/6	Eastern Extension, Australasia & China	10	12⅞
1 Feb.	6%	— 6% Deb., 1891	100	104
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	102
28 Mar.	8/3	German Union	10	9½
12 April	2/0	Globe Telegraph Trust	10	6⅞
12 April	3/0	— 6% Pref.	10	14¼
30 April	5/0	Great Northern	10	14¼
1 Mar.	5%	Gt. Northern 5% Deb., '83.	100	108
29 Feb.	10/0	India Rubber, G. P. & Tel.	10	17½
11 May	37/6	Indo-European	25	38
30 May	3/0	London Platino-Brazilian	10	6¼
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	⅜
26 April	4/0	Reuter's	8	8
		Swan United	3½	2⅜
15 Feb.	15½%	Submarine	100	150
15 Oct.	6%	Submarine Cable Trust	100	97
29 Feb.	36/0	Telegraph Construction	12	39½
3 Jan.	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
		West African	10	5¼
1 Mar.	5%	— 5% Debs.	100	95
12 July	4/0	West Coast of America	10	6¼
30 June	8%	— 8% Debs.	100	117
11 May	9/	Western and Brazilian	15	11⅜
11 May	6/10½	— Preferred	7½	7⅛
11 May	2/1½	— Deferred	7½	4⅝
1 Feb.	6%	— 6% A	100	113
1 Feb.	6%	— 6% B	100	108
		West India and Panama	10	1⅜
30 May	10/0	— 6% 1st Pref.	10	11½
13 May, '80		— 6% 2nd Pref.	10	7¾
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	104

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NOTES.

Brussels.—The electric light is to be installed at the Midi Station, Brussels.

Overhead v. Conduit.—The cost of the best overhead line for an electric railway, on engineering authority, is about one-tenth the cost of a conduit system.

Personal.—Mr. Henry Cunynghame, the well-known author of the work on the Electric Lighting Act of 1882, has been appointed to the secretaryship of the Parnell Commission.

Electric Bridge Railway.—The Thomson-Houston Company are going to construct an electric road over the Missouri River, to connect Omaha with the other side over a special bridge.

Calcutta.—We understand that the Calcutta agent of one of the English firms has secured the contract for lighting the United Service and Bengal Clubs with electric light at an early date.

Sea-Bathing by Arc Light.—A tall arc light has been erected about thirty feet out from the shore at Crescent Beach, near Boston, U.S., so that the bathers can disport themselves at night under the arc's mild beam.

Malvern.—Application has been made to the Local Board for leave to put overhead telephone wires at Malvern. Any electrical work there will have to be underground, however, for the Board will not allow any overhead wires in their picturesque watering place.

Lincrusta Pushes.—Pushes for electric bells made with covers of Lincrusta-Walton washable wall-paper, to match the decoration of the room, are the latest thing in this line. They are introduced by Messrs. Woodhouse and Rawson, and are made in various colours and patterns.

A Large Installation.—Kansas is busy preparing for a large central station for distributing steam of 3,500 h.p., four electric light stations with a total capacity of 10,000 incandescent and 1,000 arc lights, with the piping and wiring of the entire city to distribute light, heat and power.

The Tesla Motor.—The patents of Mr. Nikola Tesla, whose invention of the alternate current motor were recently described by us, have been purchased by the Westinghouse Company. The manufacturing preliminaries are being pushed forward, and the Tesla motors will soon be in the market.

Canada.—The Edison patents having been more or less upset in England and the United States, efforts are being made to annul the patent for Canada. The plea is non-compliance with the Patent Act, and the Westinghouse, the United States, and the Consolidated Electric Light Companies are contesting the Edison patents.

A Bureau of Electrical Testing.—The Johns Hopkins University will establish an authorised department for the comparison and standardising of electrical instruments for America. The work will be directed by Dr. Henry A. Rowland, and the comparisons will be made by Dr. G. A. Liebig, who has been appointed assistant in electricity.

Without Conductors.—The Ansonia railway is run on the Thomson-Houston system, which, it is well known, is not a storage method. It was therefore surprising at first to read that the line "is a complete success in every respect, and was the first to run electric cars without conductors." On reflection it is evident that it is "not that sort" of conductor they do without.

Second-hand Plant.—It has been suggested that a list corrected and issued weekly of new and second-hand plant, to be disposed of or hired on favourable terms, would be advantageous to the industry. We have made arrangements to carry out this suggestion, and this week give a specimen list of such plant. As far as possible, samples of the goods to be sold will be found at the office.

Carriage Traction.—It will be remembered that a short time ago M. Volk, of Brighton, fitted up a carriage with accumulators, and ran the carriage over considerable distances by the aid of electricity. The description of this experiment caused the powers that be at Constantinople to desire a similar carriage, and we understand one was ordered, which is being fitted up by Messrs. Immisch.

Lightning in a Post Office.—During one of the late thunderstorms a telegraph instrument at the Brigg railway station was struck and damaged, and much alarm was caused at the post office at the same place by a loud report proceeding from a telegraph instrument. The office immediately afterwards filled with smoke, but fortunately nothing took fire and no personal injury was sustained.

Bank of England.—The electric light seems to be appreciated at the Bank of England. After a careful trial of electricity, the authorities have found the advantages of the light so evident, that they continue to extend the system. Messrs. Drake and Gorham have just completed an installation for the supply of 500 lights, and have now received instructions to put down two additional engines for lighting another set of offices.

Accumulators at Sea.—The English Admiralty are beginning to recognise the advantages of accumulators for ship-lighting, a fact which has long been evident to many foreign powers. As a result Messrs. Drake and Gorham have recently received instructions to fit batteries to both the Royal yachts, and they are now supplying a similar set of their special ship-lighting cells for the "Britannia" and the "Hindostan."

Chicago Underground Railway.—Chicago is trying to get an underground railway on the model of London, but run and lighted by electricity, with a circuit of twenty-seven miles. Elevators will be used to bring the people to the street level. A company has been formed with a capital of 27 million dollars. The plan is feasible enough in the present state of engineering; but the question is, will it pay on the large outlay?

Ratios of Electric Conductivity.—F. Kohlrausch has given in *Wiedemann's Annalen*, No. 4, the electric conductivity of hard steel as 3·3, soft steel at 5·5, and wrought iron as 7·6, mercury being 1; while their thermal conductivities in C.G.S. units were: Hard steel, 0·062; soft steel 0·111; wrought iron, 0·152; the ratios being the same. Hence the conditions that determine the conduction of heat and electricity are the same.

Henley's Price List.—We have received the new price list of Messrs. W. T. Henley's, Limited, relating to electric light cables insulated with indiarubber and with vulcanised indiarubber. Similar lists are given for lighted wires for internal work. These lists give not only the prices but other information relating to conductivity, diameter of wire, weight per mile, &c. Of course we cannot enter into any comparison of prices—that is the work of purchasers.

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Otto Engines at Toulouse.—An installation has just been completed at Toulouse, which is noticeable from the fact that the motive power is supplied by two 50 h p. two-cylinder Otto gas-engines. These drive two 500-light dynamos, and supply light for the Theatre du Capitole of Toulouse. The lamps are supplied on two separate circuits, so that if one fails the other still partially lights the whole place. The installation has been undertaken by the Toulouse Gas Company.

Thomson-Houston Patents.—News has just reached us from the United States that the American courts have decided that the Thomson-Houston Company are in possession of the fundamental patent on the automatic regulation of dynamo machines, as against the so-called "American" and all other systems. Messrs. Laing, Wharton, and Down confirm this information, which will probably be followed by similar proceedings by the Thomson-Houston Company to protect their inventions in other countries.

Government Lighting at Washington.—The Interior Department at Washington has purchased, and is now putting in place, a Brush electric light plant capable of furnishing 800 lights. The plant will cost about £2,000, and will be operated by department employés. The cost of lighting the department building has hitherto been about £100 per month, £40 for gas and £60 for electric lights furnished by a local company. It is expected that under the new system the cost of lighting will be reduced more than one-half.

Electric Bulletins.— Mr. Patrick Delany has perfected an apparatus for use simultaneously in a series of offices, like the Stock Exchange "tickers," but which will give short temporary messages in actual letters. These are exhibited in a telegraphic frame, actuated by electrical devices, each controlling an alphabet, and the message thus appears in the spaces. A bell calls the attention of people in the office or members of the club, &c., where the apparatus is in use to the receipt of the message, which stays in sight until the next message appears.

Slow-Speed Electric Trains.—It is said that one of the attractions at the Paris Exposition of 1889 will be a railway train, consisting of 400 platform cars driven by electro-motors and running in a continuous circle. The line will be sunk so that the platform will be on a level with the surface; the train will run slowly enough to permit the ordinary train-catching person to step on and off while it is in motion, but for the accommodation of elderly and nervous people, a stop of 15 seconds every minute will be made to allow them to pass on or off or over the platform.

Suspension Electric Railway.—Mr. R. Clark Forsyth is the inventor of one of the latest schemes for electric suburban traction, and intends to try the system in Chicago. It consists essentially of overhead passenger cars swung from four wheels on the roof, which run on a single rail carried in the manner of a suspension bridge by a lattice of struts and ties. At each street intersection is to be a pier of structural ironwork, over the apex of which pass the suspension cables. The electric rail runs in a straight line suspended from this, and the car hangs in mid-air below this. Double lines would be provided for crossing.

Cables to India.—The Indo-European Telegraph Company notify that, in addition to the interruption of the Eastern Company's cables between Aden and Bombay, reported on the 11th of this month, one of the cables of the Indian Government between Bushire and Jask, in the Persian Gulf, broke down on the 13th inst. at noon. The Indian Government has now, therefore, only one working cable by the Indo-European route, and there is, consequently, heavy delay on messages. The Government repairing steamer, "Patrick Stewart," is on her way to the fault, and the repairs are expected to be completed between the 20th and 22nd inst.

Prizes for Electric Meters.—The Conseil Municipal of Paris have decided to hold a collection of the various kinds of electric meters, and have voted a sum of 20,000f. to be distributed as prizes, under the following conditions: 10,000f. to the inventor who produces a meter giving entire satisfaction; five prizes of 2,000f. to the five inventors whose meters, after this, show the most important progress realised. Where the meter is only applicable to one of the two forms of current, direct and alternating, only half of the prize will be awarded. The town of Paris reserves the right to manufacture the prize meters for its own use without further payment.

Lighting the Cars in the Tunnel.—The elevated railroad at Kansas passes through a tunnel, and a contract has been entered into with the City Electric Light Company to light the cars for the time only that they are passing through the tunnel. This is accomplished by means of automatic apparatus, which turns the light on when the cars enter and off when they leave the tunnel. On the top of the car is a V-shaped standard which comes into contact with a bare insulated wire strung through the tunnel, and is held in contact therewith by a spring. The standard leaves the wire when coming out of the tunnel, and the light, of course, is turned off.

Fire Alarm in Electric Stations.—A serious accident happened recently at New Orleans, where a sudden fire broke out through the dropping of a light in a bucket of oil, and put out all the lights, in many cases where no gas connections existed. It would seem an almost impossible thing to burn down an electric light plant; but the thing has happened more than once in America. A satisfactory arrangement would be to have an automatic alarm connected with the fire brigade in case such an accident occurred. In the case mentioned what made the matter worse was that the fire-alarm office itself was in darkness through failure of the lights.

Buckingham.—We are glad to see that the local electric light company has got to work in Buckingham. Sufficient shares having been applied for in the Buckingham Electric Light and Power Supply Company, the directors have decided to proceed with the installation at once. A few evenings ago they visited and inspected the Old Tan Yard, which is to be the central station, and took measurements. They also ordered the necessary machinery, steam-engine, and electric plant, and decided upon the structural alterations of the building. They hope to have several establishments in the town lighted up with the electric light during the next month.

Paris Electric Roads.—Electric traction for Paris is in the air. We have recently had the project of M. Berlier, which was for an underground railway, consisting of a cast-iron tube 18ft. in diameter, run without taking up the roadway from the Bois de Vincennes to the Bois de Boulogne. Electricity was to be used in this tunnel, the tube itself to constitute the return. This scheme was

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rejected by the Paris Council. Now another scheme is being introduced to the municipal authorities to run a single-rail overhead road, also run by electricity, at the time of the Exposition of 1889, which is to connect a large number of the boulevards of Paris, and to have connection to the exhibition grounds in the Place du Trocadero.

Utilising the Force of an Artesian Well.—Instances are now fairly common where the downward force of falling water has been utilised to furnish motive power for driving dynamos, but to make the upward force of a fountain serve for this purpose seems a little out of the question. Yet this, nevertheless, is what is proposed to be done in the case of artesian wells. The first installation of this kind exists in Florida. The artesian well in question has a diameter of nearly 12in., and is about 500 yards deep, and ten million gallons of water per day rushes out of this aperture. A turbine-wheel is placed at the outlet, serving to drive a dynamo which lights the surrounding buildings, and the installation works with great success owing to the extreme regularity of the water supply.

Patents.—"It is an ill wind that blows nobody good," says the old saw, and our American contemporaries must be pleased with the various legal opinions on the battles fought in law courts over incandescent lamp patents, for the competing companies are largely advertising, each of course, claiming decisions in its favour and as pulverising its opponents. We are practically certain that the money spent over these lawsuits will never be repaid to the companies during the life of the patents. A good business maxim, and one to be commended, is that which says, "Keep on experimenting, take out a patent for an improvement that can be shown to be an improvement about every fourth year, let all your clients, and all who may be clients, know of the improvement, while ostentatiously dropping the previous manufacture. One word—don't make too much of your improvement before the old stock is run low, and the new stock ready, or buyers will reject the old in favour of the new."

Underground Telephone Wires.—Brooklyn, the aristocratic suburb of New York, has now a most complete underground telephone system, the whole of the wires being brought into the exchange entirely underground, and there are no fixtures of any kind on the roof. The conduits are of creosoted wood, with ducts two or three inches in diameter, and laid in banks of from four up to thirty-six when nearer the office. The company consider the durability of creosoted wood for conduit is thoroughly established, and their method of construction permits the handling of the cables easily, both in drawing in and hauling out. The arrangements of switchboards, &c., is very complete, and the substitution of underground wires has been carried out without many of the subscribers being aware of the change. There are at present 2,100 miles of wire placed in the conduits. The remainder of the poles on the outskirts of the city will be taken down and underground wires substituted during this year. The exchange has 3,581 subscribers, of whom 1,600 subscribers are on the underground service.

Charging Stations on the Thames.—Now the question of electric launches on the Thames, with their accompanying charging stations, has been mooted to the public and satisfactorily received, it may be well to make a suggestion which will tend, during the coming seasons, to make the method of pleasure-tripping both easy for the pleasure-seekers and convenient to the suppliers of energy. The proposal has been made to put up a number of floating stations, at one firm's risk, at different places up the river Thames. This may be possible, but we fancy a better way would be this: It is well known that from Richmond up there are a series of first-class hotels, which combine the business of boat-letting, luncheon-providers, and hotel. Tagg's Hotel is a sample one, and another very large hotel is being built on the island off Weybridge. Once the fashion for the quick-moving, silent, and comfortable little electric launches sets in—as it must soon—these hotels will be glad enough to cater for their customers for "electric energy" as for "cutlets and salad." A charging station at each of these hotels would be a convenient source of power for launches, and an additional source of income to the riverside hotels; and the plant necessary for this purpose could be utilised to provide the hotel itself with that most desirable and coveted of luxuries—the electric light, practically with the minimum possible cost.

Jointing Phosphor-Bronze Wires without Heat. The following abstract from the *Electrotechnische Zeitschrift*, part 4, 1888, is given in the *Journal* of the Society of Telegraph Engineers and Electricians, upon a method for jointing phosphor-bronze wires without any application of heat: "It is very desirable to avoid by all means the heating of phosphor-bronze wires, as this leads to a decrease of the breaking strain; and consequently some means of jointing had to be sought for which might replace the method of soldering used for iron wires. Moreover, experience has shown that some local action is set up between the tin solder and the iron wires, which in time leads to a weakening of the joint; such action would of course be still greater with phosphor-bronze wires, owing to the greater affinity of tin and copper. The best substitute for solder is a copper amalgam prepared as follows: Freshly precipitated copper oxide is heated in a tube in a stream of hydrogen until it is reduced to metallic copper. When thoroughly cooled, this fine copper powder is moistened with dilute sulphuric acid and well mixed with mercury, and is then washed. A simpler plan, though not such a good one, is to obtain the copper powder by reducing copper sulphate by means of metallic zinc. In making use of this amalgam for jointing wires, it is pressed closely round them and allowed to set. On this account a twisted joint is not very well adapted; a Britannia joint is better, as the amalgam penetrates inside the binding wire. But the best joint is made with a tube connection, the two ends of the wires being turned up at not too sharp an angle and secured with binding wire; the amalgam is then pressed well into the tube, where it sets quite hard."

Intercepting Telegrams.—The Austrian War Office, says the *Times*, is stated to be paying great attention to a matter which is of the greatest importance in the use of the telegraph in the field. It has been ascertained that the telephone is so acute of hearing that before it every secrecy of telegraphing disappears. If, formerly, it was desired to ascertain the secrets of the telegraph wire, the latter had to be cut and an apparatus inserted. Now, with the help of the telephone, all telegrams may be read easily, even from a considerable distance. It is only necessary to carry a telegraph wire of moderate length parallel to the original line, and insert in it a telephone, from which the Morse signs may be read off by the ear. This would, of course, be very awkward in the case of war telegrams. Even guarding the line would be of no use, for the enemy may, at a safe distance, say, half a mile from the telegraph line,

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where he could not be seen, secretly set up his intercepting apparatus, consisting of a hundred yards of parallel wire and a telephone. The question has naturally arisen how this difficulty is to be met. The problem is solved in a surprisingly simple manner by Herr Heinrich Discher, who proposes cross telegraphing for the purpose. He says that, if telegrams are sent from opposite directions on the same wire at the same time, the listener at the telephone only hears a medley of confused sounds. In practice the matter may be dealt with in the following manner: One station sends actual telegrams, the other a despatch previously agreed upon. As long as the operator at the former station sees this despatch coming in, he may make sure that no eavesdropper is able to read the telegrams he is sending.

The Sprague System a Complete Success.—We finish to-day the interesting and exhaustive account of Mr. F. J. Sprague's electric road at Richmond. We announce at the same time the effect the success of these experiments have had in the substitution of the electric for a proposed cable system in England. The following is an independent testimony of the success of the Sprague system by the president of one of the street tramway companies of America, who have adopted the system of electric traction: "Wilmington, Delaware, June 14, 1888. The Sprague Electric Railway and Motor Company. Gentlemen,—I desire to express to you our entire satisfaction with the overhead system of electric propulsion of street cars as constructed by you on the Riverview extension of our line. The system has been in operation here for three months, and from a practical experience during that time we can pronounce it a complete success. In fact, we consider it by all odds the best and most economical mode of running street cars in suburban districts, or in any place where permission to erect poles can be obtained. In comparison with horse-power, we find it decidedly cheaper and more efficient in every way. It is popular with our patrons on account of its cleanliness, its smooth and rapid motion, and especially for the absence of the usually overtasked and labouring horse. Our road is quite hilly, and the cars, loaded sometimes with seventy passengers, climb with ease, at the rate of five miles an hour, a 5½ per cent. grade, having a 90ft. curve. The cars are 16ft. long, and each has been running continuously from the start sixteen hours a day, making 64 miles daily on the 1⅛ miles of our extension. At first, many persons here were sceptical about the successful use of electricity as a motive power instead of horses, but the practical demonstration made on our line has converted them, and directors, press and public have only words of praise for electricity, and endorse it as the future motive power for street car traffic. Each member of our Board fully approves the above statements.—Wishing you every success, I remain, yours, &c., William Canby, President Wilmington City Railway Co."

The Thames Subway.—At last we are to have a real working electric railway in London. The shareholders of the City of London and Southwark Subway Company, meeting last Tuesday afternoon at Winchester House, authorised the directors to make arrangements for working the line by electricity. The subway has been in progress for some considerable time, and, when complete, will connect the City side of London Bridge to the Swan at Stockwell, with intermediate stations underground. The line was intended to have been worked on the endless cable system which was said to have given very satisfactory results in America. Here, as is also now the case in America, directors of tramways are anxiously studying electric traction, and the absolutely convincing proofs of its superiority in point of ease, comfort, outlay, and cost of maintenance, have decided several American companies intending to put down cable lines to abandon that idea and to substitute the electric roads for these. This has been the case with the subway scheme, and from the statement of the chairman, the directors have satisfied themselves conclusively, after careful investigation, that the line can be more thoroughly, efficiently, and economically worked by electricity. Several eminent firms have, they say, expressed their readiness to undertake the work, the system which they propose to adopt being that of continuous conductors, and are so sanguine of success that they have offered to work the line on favourable terms for a number of years. One or two of the shareholders present at the meeting objected to the action of the Board in discarding the original idea of a cable for what, they considered, the more risky electrical system, but eventually the resolution proposed by the chairman was sanctioned. It was stated during the proceedings that the engineer hopes to get that portion of the subway between the City and the Elephant and Castle completed by the end of the year. We shall watch with interest the carrying out of this scheme. From practical examples we have before us in England, America, and elsewhere, there should not be the slightest difficulty in making this not only a practicable line, but a successful one financially, and we feel sure it will be the beginning of a series of similar undertakings where the tractability and cleanliness of this method of traction will be utilised for the public good.

The "Norham Castle."—The equipment of a passenger steamer is not thought complete nowadays without the luxury of the electric light, and not many of the ships of our mercantile steam-passenger service are now without the light. One of the latest additions is that of the "Norham Castle," one of the Donald Currie mail steamers to the Cape. This vessel has recently been fitted by the Brush Corporation throughout with electric light, comprising 332 incandescent lamps. The main saloons have 28 lamps with shaded globes, and the second and third-class cabins and quarters of the officers and crew are also lighted. Each passenger state-room has a 16 c.p. lamp with its own switch at the side of the berth, being arranged with the greatest convenience for passengers. The signal lamps are also illuminated by electricity in the manner described last week; and a submarine lamp is also fitted, by aid of which the propeller blade and any part of the bottom of the vessel may be inspected. There are two sets of electric plant—viz.: two Tangye-Archer engines, 9in. by 8in.; these run at the very slow speed of 200 revolutions per minute, and are coupled direct to two F2 "Victoria" dynamos by Raworth's patent flexible flywheel coupling. Each dynamo gives an output of about 11,000 watts at 100 volts. There are about 320 16 c.p. lamps in neatly designed fittings, and there are also three cargo lanterns, each fitted with four 16 c.p. lamps, making a total of 332 lamps of 16 c.p. each. These lanterns can be attached to any of the numerous connections along the deck, and by the aid of lengths of cable to each the whole of the upper deck can be illuminated when required for entertainments, balls, &c. In the engine-room, stoke-holds, and tunnel there are thirty strong fixed lamps, and four strongly-guarded portable lamps, with suitable lengths of flexible cable attached,

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and there is no part of the engine-room, stoke-hold, tunnel, or coal bunkers that cannot be examined. The wiring is carried out entirely on the single-wire system, and every part of the wiring can be inspected should it be required. None of the wires throughout the ship are in any instance run behind panels, and in the first saloon all the wires are led on the surface of the mouldings and panels. None of the ship's mouldings have been interfered with, the wires being covered by special and suitable mouldings, designed by the Brush Corporation, to harmonise with the existing ship's mouldings, the whole presenting a neat and elegant appearance when finished.

Harold P. Brown and the Dog.—A young gentleman of the name of Harold P. Brown has been raising the dust in New York by his attack on alternating currents. He alleges that, practically, only direct current circuits are safe, and has drawn up a set of rules which he would like to see enforced by the Board of Control. He has been variously and vigorously sat upon by the electrical engineers all round. Last week, to demonstrate his theory, he made a public demonstration of the effect of various currents upon a luckless dog. His demonstration seems to have been carried out in the most haphazard, unscientific manner; connections were left to be made by twisting wires together, the condition of the dog was not stated, and the same dog was used throughout. Connection was made by twisting some wet waste round his right forefoot and left hindfoot, and the resulting resistance was announced as that "of the dog." No comparison was really effected, though the dog was eventually killed by an alternating current, for the same dog took the whole of the shocks—first with 300 volts continuous current, afterwards increased to 500, and then to 1,000, during which time the dog nearly strangled himself with his futile struggles. He was then given a shock of 330 volts, alternating current, which finished him off. The so-called demonstration has been made the subject of much ridicule by the technical press. Our contemporary, the New York *Electrical Review*, in describing the experiments, rightly stigmatises them as worse than useless, and says: "Had the order been reversed, and the alternating current been administered first, it is much more than probable that a final dose of 330 volts continuous current would have been quite as effectual to kill. It was much like pounding a man to jelly with a club, and then changing weapons and finishing him with a merciful bullet. Nothing is proved; but it would be a good thing if one of the wealthy companies authorised a series of conclusive experiments under proper conditions. If dogs are to be the subjects, let there be a fresh dog for every shock, and let the dogs be well fed and conditioned, and not a lot of poor half-starved vagrants from the pound. And, above all, let the tests be made in a true scientific spirit, which looks not to prove anything but the exact truth, and by a body of men who know the importance of making comparisons only under exactly similar conditions. Such demonstrations would be reliable, and their conclusions irrefutable."

Electric Expressage.— We notice that the *Street Railway Gazette* gives detailed drawings of Weems' electric expressage, which we have already noticed, a system by which papers and parcels are to be shot across the country at the rate of 400 miles an hour, reaching the Pacific from New York in nine hours. The whole idea is American in its daring, its immensity, and also in its necessity. The interest on valuable bonds of thousands of dollars' value is worth saving when the passage takes three days, but in England, what with the Great Northern accelerations of London to Scotland in eight hours, such extremes of swiftness are hardly so necessary. So we may let the Americans experiment with newspaper projectiles. The designs show a low car, like a huge shuttle, mounted with six wheels, two at each end and two along the centre at the top. This car is to run on a strong overhead frame carrying single or double sets of rails, and can be carried across country in a straight line. The Electro-Automatic Transit Company of Baltimore has been incorporated to carry out these designs, with a strong board of directors, and the enterprise, we are assured, is no longer only a "scheme," but has assumed a practical shape, and a line is to be built at once from Washington to Baltimore. "It has created an intense interest," says their report, "in scientific and railway circles, and it has been pronounced eminently practicable. It bids fair, at an early day, to revolutionise the world on the question of rapid transit." It is curious to note the way in which electric marvels follow each other; scarcely has one apparent impossibility been brought before the world, disbelieved, laughed at, carried out and become useful, than another comes to take the breath away. It is proposed also to institute a similar quick delivery in towns in underground tubes, for delivery of parcels, newspapers, &c., but its greatest usefulness would be for cross-country work. "In the momentous question of the present age," the prospectus goes on to say, "which is the struggle for the mastery over time, the use of electric force is making such strides and attracting such attention in the world of mechanics, as to render its general adoption in all cases where power is necessary merely a question of time. By the use of this force, intelligently handled, rapid transit can be readily obtained in its fullest meaning, and if time is money, it holds good that money will also be saved. A handsome sum per day was offered by a clearing house and a number of merchants in one of the large western cities for a train saving eight hours, which would have saved one day's interest on exchanges, but the road was unable to accommodate them. The use of electric force has been brought to bear upon this particular subject in the system herein treated of, which will be found to be not only feasible, but eminently practicable." This lightning railway is to consist of a light structure, elevated some 20ft. from the ground. A permanent generator, of prescribed horse-power, is to be located at each end of the line, from which the current will pass to the conducting rail, and will be immediately taken up by the travelling motor, to which one or more cars can be attached. On approaching its destination, it will pass a certain defined point where the electric current will be cut off, leaving the train to its own momentum, which will gradually decrease. Each car then will encounter a trip lever, located at a sufficient distance from the stopping place, which will spring the brakes in succession, bringing the train to a standstill at a designated point. The cost of such a railway is figured out to be the exact sum of £1,016 per mile for a double track, and £670 per mile for a single track. It has, of course, been suggested that passengers may even be eventually sent over these lines, possibly in a recumbent posture at the rate of several miles a minute. The feeling such an idea inspires will give us a very good idea of the feeling with which our forefathers regarded the introduction of modern railways. Whether this is also possible, time alone will show.

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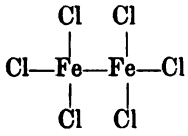
THE CHARGE ON THE ATOM.

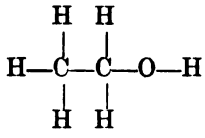
BY J. ENRIGHT, B.Sc., LOND.

(Concluded from page 124.)

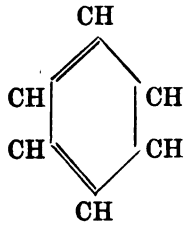
To return to the question of valency. The doctrine of "the charge on the atom" undoubtedly gave the term a new signification. For a lifeless hypothetical bond it gave a hypothetical charge of electricity, and inasmuch as we know that an insulated charge of electricity is capable of doing work, the new conception is more satisfying. But the new and the old are not always at one, and as the matter is looked into the feeling of satisfaction does not grow. No difficulty appears with regard to the simpler cases, such as HCl, KI, $MnCl_4$, CH_4, CCl_4, PCl_5, &c., but take Fe_2Cl_6. The graphic formula indicates that the stability of the molecule depends upon the cohesion between the two atoms of iron.

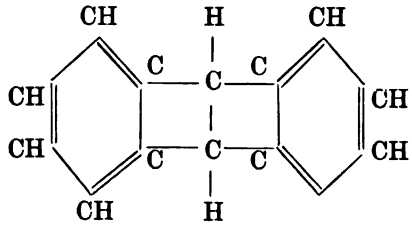


But the iron is understood to be charged positively, and the repulsion between atoms with charges of the same sign would rather tend to destroy the molecule than to keep it intact. This, as will be apparent to everybody, is a typical case. If there be anything in the point I have just raised, we are only on the very fringe of our trouble. Graphic representation has been of greater use in organic chemistry than in the inorganic branch of the subject, but the theory appears to reduce it to an absurdity. Consider the graphic formula of any one of the alcohols. Here we represent the molecule as kept in its integrity by the charges on the two carbon atoms, but as the charges on



them are of the same sign, repulsion, and not attraction, ought to result. If "the atom of every chemical element is always united with a definite unvarying quantity of electricity" (to use the words of Sir H. Roscoe), where are we to find "the mighty electric attraction" (Helmholtz) which is supposed to hold the atoms of the molecule together? The members of the open chain series became the most unstable things imaginable. But what of the "closed chain" series? Written graphically, they look explosive compounds. Examine the formula of benzene or anthracene, and say if anyone can fairly maintain that all the carbon atoms are charged and that the charges are of the same sign.





According to our theory, then, the "open chain series," the "closed chain series," the whole organic would—in fact, ought to—go to pieces, and no one can explain how it pulled itself together at first. Chemists who hold the Helmholtz theory must give up writing graphic formulæ as of yore.

The change of valency of elements constitutes another difficulty. Ferrous may be oxidised into ferric salts:

$$2\,Fe^{II}SO_4 + H_2SO_4 + Cl_2 = Fe^{IV}_2(SO_4)_3 + 2\,HCl.$$

In the ferrous salt on the left, the atom of iron is endowed with two monad equivalents of positive electricity. In the ferric salt on the other side, each atom of iron is attached to four monad equivalents of the same sign. I see no difficulty in understanding that an atom may hold twice or thrice as much electricity at one time as at another; but I cannot see, neither in this nor in similar cases, whence the increment comes. The chlorine and the sulphuric acid go in neutral, and the only source of electrification under the circumstances is the contact of the different substances. As I have already indicated, I believe that if the doctrine of "the charge on the atom" can be reconciled with facts, it will be through the friendly aid of the electricity of contact; but, even with this belief, I cannot devise any mode of explanation which can satisfy even myself of the increase in the quantity of electricity in cases of oxidisation. Further, if such an increase really took place, I consider that we ought to be able to detect it by means of the electrometer. I have allowed such oxidisation to go on in insulated vessels connected to one pair of the quads, the other being to earth, when the instrument was in as sensitive a state as I could make it, but without detecting any electrification.

Then again, the radical SO_4 is a dyad, and as such is endowed with two monad negative charges, yet we represent three of them containing six monad equivalents of negative as satisfying the eight monad positive equivalents of the two atoms of tetrad iron. Something will have to give way. Either the dyad nature of the SO_4, or the tetrad nature of the iron, or the theory.

There are many other difficulties of this kind which suggest themselves, but I don't see that much is to be gained by an accumulation of objections founded on the theory of atomicity, for if those already raised be well founded they appear sufficient.

I hope I am not disposed to take a narrow view of graphic formulæ and the system of bonds. I am satisfied with any view however lax and vague, provided there is left in it sufficient usefulness to enable one to understand isomerism in its many forms. Any modifying explanations which would wash such utility out of the system would, I think, render it useless, and to any form of it which retains such utility I believe the criticisms I have made would apply.

The theory which Helmholtz taught is of tremendous amplitude. It extends into physical science in all directions, but in the famous Faraday lecture only one side of it—one might say, only one facet of the great subject is dealt with. Nothing more, of course, could be done, and nothing could be more interesting and enjoyable than a treatment of the somewhat cranky subject of electrolysis by the great Professor; but can it be said that the facts of electrolysis were the best suited to test the theory which he proposed to expound? It would be ridiculous for one to pretend to lay down the law, but, judging from other cases, it would appear that it is the better known and simpler rather than the obscure and abstruse facts of a subject which supply the basis of a theory. At all events, no theory which does not give a ready explanation of the former can long survive. The electrolyte only is examined and examined only at one end of its career, at its destruction. But I submit that for the purpose of ascertaining whether or not a "charge on the atom" is essential to the existence of the molecule, a close scrutiny of its formation is as likely, if not more so, to give the desired information, and it is to this aspect of the question that I would now direct attention.

Helmholtz lays it down, as the following passages show, that when the ions are liberated from the electrolyte by the agency of the galvanic current, their charges are given up and they become neutral.

"At the surface of the electrodes decomposition can take place if there be sufficient E.M.F., and then the atoms give off their electric charges and become electrically neutral." And, again: "Hitherto we have supposed that the ion with its electric charge is separated from the fluid. But the ponderable atoms can give off their electricity to the electrodes, and remain in the liquid, being now electrically neutral."

It is unnecessary to quote further as his ground appears to be most clearly defined. Now, as the ions on liberation, by the action of the current, become neutral, and as the very existence of a molecule requires that the ions composing it shall possess a charge, it follows that at the formation of a molecule some machinery must be at hand to produce the indispensable electricity—a supply of positive for the

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cation, and a supply of negative for the anion. The difficulty of proving a negative is very great, and I am bound to admit that I cannot prove that such machinery does not exist. On the other hand, no one has detected such machinery—at least, as far as I can ascertain. I have myself, as already stated, vainly endeavoured to detect electrification during the formation of salts, but I recognise that such a thing may conceivably go on without its admitting of detection.

However, although we cannot be sure on this point, it is easy to deprive the region in which a salt is being produced of all positive or of all negative electricity, and so according to the theory to prevent or arrest the formation of molecules. Let an insulated hemisphere or cylinder of zinc be connected to the prime conductor of a Holtz's machine, and let it, by continuous working of the machine, be kept strongly charged negatively while a drop or two of dilute H_2SO_4 is dropped on it by means of a glass rod (insulating rod). The theory makes the formation of zinc sulphate impossible for want of positive electricity, but effervescence takes place, and the sulphate is undoubtedly formed. It is difficult to see how any charge of positive electricity that may by any known or unknown means be developed on the zinc can do other work than that of neutralising a portion of the negative charge on itself and the conductors connected to it, as long as the prime conductor and the zinc are kept negatively charged by continuous working the machine. If this be so, according to the theory no molecule could be formed. The only difference noticeable between the experiment when made as described and when under no electrical influence is that the effervescence is more violent (in the former case).

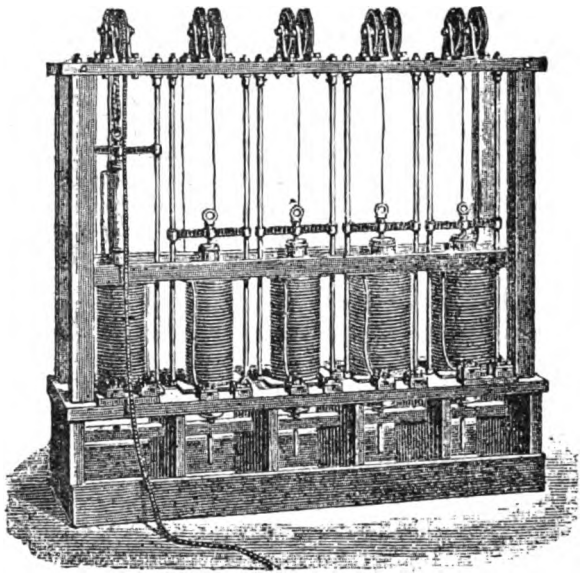
There appears yet another simple means of deciding the issue. A solution of cupric nitrate is easily electrolysed. An E.M.F. of less than three volts is ample to deposit copper from such a solution. Any E.M.F. exceeding this which can be used to keep copper and nitric acid apart, ought to prevent the formation of the molecule $Cu(NO_3)_2$. In order to apply this test the current from six Bunsen's cells was passed through strong nitric acid, the positive electrode being platinum, the negative a strip of copper. Gas was freely disengaged from both electrodes, which were about one inch apart, and the liquid rapidly became blue. In this experiment the whole force of the current tended not only to keep the copper in its integrity, but to cast any metallic impunity in the acid on the copper, and if, according to Helmholtz, there were only the electric forces to cause the ions to combine, cupric nitrate could not possibly be produced. This experiment was varied by covering the copper electrode with paraffin, except a part of that surface which directly confronted the platinum electrode, but, as had been expected, the result was the same.

In conclusion, I wish to point out that the theory of "dissociation" appears to be discredited by the facts and arguments by which it has been tested. The tardy precipitation from certain mixtures which are electrolytes, and therefore have a quantity of randomly moving oppositely charged ions traversing them, the hastening of precipitation from such mixtures by the agency of the galvanic current, the more rapid precipitation from the same mixtures when more concentrated, and therefore traversed by less rambling ions (according to the orthodox), are all decidedly against it. Then it derives no support, but rather the reverse, from the argument founded on the heat of combination of ions, which might be expected to cast light on the subject, and, lastly, no sudden fall of conductuity arising from an increase of current, which may on the theory be expected to occur in electrolytes, has been observed.

The objections set forth to the teaching of Helmholtz have been suggested from time to time by attempts on my part to explain by means of the "charge on the atom" and contact electricity common chemical facts. The case of catalysis given is the only instance in which it has been in this way effective. Many attempts to get some evidence of the atomic charges were made, but without success. This, of course, proves nothing. Helmholtz, however, represents chemical affinity as no longer a thing *sui generis*, but as the result of the attractions of oppositely charged ions, and this view, I submit, is positively disproved (1) by the experiments made by myself as well as by one cited from Prof. Lodge, and (2) by the admitted position and arrangement of atoms in the molecule, particularly in the organic molecule.

SELF-INDUCTION REGULATOR FOR THEATRE LIGHTING.

The conditions of incandescent electric lighting in theatres differ from those of ordinary house-lighting in that a necessity exists for raising and lowering the brilliancy of the lamps for obtaining stage effects. With gas, there is no difficulty, as all that is necessary is to turn the gas-tap supplying the foot-lights and other branches, and, with a fairly long handle, this simple method of regulation is quite sufficient. With the electric light, however, the matter is not so simple. The method hitherto adopted has been to insert resistances composed of lengths of iron or german silver wire in the circuit, which, by means of a movable contact allowing a longer or shorter length of wire to remain in circuit, absorbs some of the energy, which is converted in heat in the resistance. This method, though fairly convenient, being at present in use in many places where the light requires turning up and down, has yet several disadvantages. Among these are the facts that the resistance for any important installation have to be of



New Self Induction Regulator.

a considerable size, and space is by no means always available on such a crowded situation as behind the scenes of a theatre. Added to this the absorption of the energy gives out a certain amount of heat, which, when a large number of lamps are turned down, is difficult to get rid of, and is not without its own element of danger. This, of course, can be guarded against, and good ventilation can be assured to the resistance, so that this method of regulation is very commonly in use. The most serious objections to it arise from the fact that if a resistance is used to lower the light, a certain amount of electrical energy is wastefully expended, and when a system of grouping in series is used for lowering the light, the scenic effect is considerably interfered with by the sudden alteration of the lamps. The question of wasteful expenditure is more important in those cases, which are now likely rapidly to extend, where the power is not supplied by a private engine and boiler, but is paid for by meter from a central station distributing the power by means of alternate-current transformers.

A method of regulating the candle-power of incandescent lamps for theatres and other similar places under these circumstances by means of self induction coils has been designed by M. Picou, manager of the works of the Compagnie Edison at Ivry, and is described in *La Lumiere Electrique*. It has been in use at the theatre at Nancy for some time, and has performed its requirements during the last winter season with perfect success.

This arrangement consists of a coil which is interposed in

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the circuit in such a manner that its self-induction will cause currents of an opposite nature to the main current to circulate in the lamp circuit, and will decrease the current flowing, and in this manner diminish the light of the lamps. A series of self-induction coils of a moderate size will thus replace the large resistance coils to regulate the whole of the theatre lamp circuits. Each coil is composed of a ring of zinc, upon which the wire is wound. The coils are placed vertically, and are about 11in. in height; the diameter of the ring varies in the different coils. A core, made of a bundle of soft iron wire 2mm. ($\frac{1}{12}$th inch) diameter, and 16in. in length, is placed in each coil, and is regulated by counter-weights to vary the strength of the reverse current. The self-induction is greatest when the iron-wire core has a symmetrical position in the coil, with 2½in. showing at either side.

The management is extremely simple, and entirely does away with the suddenness of the alteration of the light experienced in a series-switching arrangement, and often also with resistance stands. The light is quietly and evenly lowered by altering the position of the core, and the regulation is all that could be desired. At Nancy, the regulator is placed on a wooden stand against the wall separating the stage from the saloon, and immediately below the theatre switchboard. It is thus directly under the eyes of the electrician.

The sole inconvenience that has been noticed is a slight humming of the bobbin, which is greatest when the core is farthest in. This noise can just be heard on the stage, but not at all among the audience. It is exaggerated probably by the fact that the coils are mounted upon a wooden case, which forms a kind of sounding box, but the inconvenience is so slight as not to have been found necessary to alter.

ELECTRIC WELDING AND ITS PRACTICAL APPLICATIONS.

An address was recently delivered before the Boston Electric Club, by Otis K. Stewart, on electric welding, as follows:

The history of electric welding extends over a much longer period of time than is generally supposed. Some eleven years ago Prof. Elihu Thomson, who then held the chair of Chemistry and Mechanics at the Philadelphia Central High School, was delivering a course of lectures before the Franklin Institute of that city, and among other experiments by which he intended to prove the substantially identical nature of electrical energy under any and all circumstances, he reversed an ordinary Ruhmkorf induction coil, showing thereby the difference of potential between the current in the primary and that in the secondary of the coil. In performing this experiment he brought the terminals of the coarse secondary winding of the coil into contact, and was surprised to notice that a high degree of temperature was reached instantaneously at the point of contact—in fact, such a high degree of heat that the ends were stuck quite firmly together, the copper wire being actually melted, so that it required considerable force to separate them. Instantly the thought flashed through his brain—electric welding. Prof. Thomson was, however, very busily engaged in teaching and lecturing, and in developing the Thomson-Houston system of electric lighting for the next five or six years, and it was not until, in the regular course of manufacturing electric-lighting apparatus, it became an imperative necessity to discover some means of having more perfect joint in copper wire than could then be obtained, that his mind reverted again to the old experiment at the Franklin Institute, and electric welding became an assured art.

I should like, further, to call your attention to the fact that the discovery was made several years prior to the building of a welding-machine. Several years ago (I do not remember the exact date) the necessity for welding the ends of copper wires became so imperative, that Prof. Thomson designed and built a small machine with which to weld fine wires. The experiment with this apparatus were so very successful, that the inventor decided to build larger and better apparatus, and experiment further, with a view to welding, if possible, much larger pieces of metal. These experiments were also successful, and the invention has been much further developed in the past year or two than the general public can have any possible idea of.

The theory underlying or the principle involved in the Thomson process of electric welding is very simple, as indeed is most of the apparatus also. The Thomson process of electric welding consists simply in forcing through the pieces of metal to be welded currents of such large volume that these pieces can carry them without heating. Now, when the pieces are placed in abutment, the point of greatest resistance, as you all know, is where they make contact with each other, and it is of course at this point that the heat is first generated. The instant heat is generated at the point of contact, the resistance at that place enormously increases, and a consequent more rapid development of heat is the immediate result. The metals are consequently raised to a high welding temperature in a very remarkably short space of time, and upon a slight pressure being applied to force the pieces together, a perfect welding is effected.

The field that is open for the process of electric welding is surprisingly vast, and of course no one can tell where it will lead to. I think one of the most important reasons why electric welding is taking an important place so rapidly is that the heat generated by the current is the only absolutely pure heat known in the world. The blacksmith, when welding with either a gas furnace or a coal fire, is constantly running the risk not only of burning his metal, but of introducing into it foreign matter in the form of gases, which are very deleterious to the substances of either iron or steel, which are the principal metals worked by blacksmiths.

Now, the heat generated by the electric current is absolutely free from all foreign and harmful substances, and it is this fact, I think, which very largely accounts for the rapid advance of electric welding, so far as practical work is concerned. Of course, this is not the only reason. One very important reason is the fact that the heat effected by the current is under absolutely perfect control. Now, I do not mean to say that this regulation is nearly perfect, or that it is very perfect, but I state that it is absolutely perfect, for the reason that it can be made entirely and completely automatic. The heat can be begun, and a stop put on the apparatus which will control the heat perfectly.

Then, again, welding by the Thomson process is a much neater and quicker operation than welding by the ordinary method of forge or furnace. I might also say in this connection that no skilled labour is necessary to operate an electric welding apparatus. I have before my mind now one young man who came to us not knowing anything of the conditions under which different metals should be welded, and who in a very short time has become so expert in handling these machines that he can now, on the first trial, make perfect welds in any of the ordinary metals, and in almost all varieties of steel, including, although I say it with some reservation, even Mushet steel and manganese steel.

As I have already stated, the field for electric welding is so very broad, that I have been really much embarrassed in endeavouring to present the most interesting portions of it to you this evening. There are hundreds of applications of the process, and, under the circumstances, I do not think I can do better than simply cite one or two instances or examples of very small work, and then some of larger work. We are not limited, of course, in our work by the size of the pieces to be welded. We can weld the finest wires and the heaviest pieces. As an example of quite small, though not the smallest work, I might mention the welding of gold rings. We have succeeded in welding gold rings. I want to call your attention to the fact—that I say we *have* succeeded. It is no longer a matter of experiment, but the welding of gold rings by our process is an assured success. Now, what does this mean? It means, first, that we can make a better joint than is now made, doing away entirely with soldering, and in its place making a continuous gold ring; secondly, it means that the work is accomplished in about one-fifth of the time that it now takes to make a decent joint; and it means, lastly, that soldering material is saved, that an enormous wasting of heat is done away with, and that the dangers of burning gas are entirely obviated.

As an example of somewhat larger work, I might mention the welding of axes. There is, not very far from Boston, a manufacturing establishment which turns out about three thousand axes a day. Their axe is made of a body of ordinary wrought-iron, to which is welded an edge or face of fine tool steel, tempered and toughened. Their pieces of metal, before welding, have to be prepared somewhat in this manner. That is, a groove is cut in the body of the axe while a taper is cut on the face or blade, the latter being set into the former and the pieces welded in this position.

Now, in electric welding we do away entirely with this preparation, and I am very glad to say that without very much experimenting we have been able to entirely convert the engineer of this company to electric welding. He is now a firm believer that electric welding is the thing as far as the axe business is concerned.

As an example of much larger work, I might mention the welding of pedestals and locomotive frames. This is an entirely different class of work. The pieces have to be carefully prepared, a raised portion being left on the base or edge of the frame, and a taper groove being cut in the pedestal so that it may fit down over the raised portion referred to.

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Some months ago I had the pleasure of being in Philadelphia, and while there of walking through the Baldwin Locomotive Works. This establishment is turning out fourteen locomotives a week. Now, what does this mean for electric welding? In the first place, on these engines there are some five or six copper rings, the wire composing which is of small diameter. The joints in these rings are at present made with a blowpipe flame, and it takes an expert some four or five minutes to make a single one. We can make them in as many seconds. There are also on each one of these locomotives at least one hundred and fifty joints in iron, from a half-inch area of section to several inches area. Now, it takes anywhere from four to fifteen minutes to make these joints by the ordinary process, and welding, you must remember, has been reduced to a very economical and accurate art in this establishment; but, nevertheless, we can do the work in at least one-fifth of the time which they now occupy. There are on each one of these locomotives four frames, each frame having on it at least two—sometimes three, four, and five pedestals. We will suppose that the average is three pedestals per frame. That makes twelve pedestals to the locomotive. To prepare the ends of the pedestals and the taper on the base of the frame takes some forty minutes. They have to be heated and hammered into shape while hot. After they are prepared they have to be reheated to a welding temperature, placed under a steam hammer and welded, this last operation requiring some thirty or forty minutes. You can easily see what this means. We allow twelve joints to each locomotive, and this makes 168 pedestal welds a week—168 welds which require at least one hour's time each.

In talking the matter over with the general manager of the company, I think we came to the conclusion that we could "beat this all hollow," the only question in his mind being whether the weld would be as perfect as at present. You will see that we would do away entirely with the preparation of these pieces, making a butt weld of the pedestal to the bit or expansion on the base. There are, of course, a large number of other applications, but I think that these three should be sufficient to indicate at least what the possibilities of electric welding are. There is one thing that I should like to mention finally—that we are able to make very durable, strong joints between metals of different kinds. For instance, these specimens which I hold in my hand consist of brass and copper welded together, and then twisted around twice. The joint held through this twisting, showing the strength. You will see that it is not even cracked.

What do we expect in the future for electric welding? We expect to be able to weld boiler plates. We do not say that we are able to do it now, but we have been thinking over the matter and experimenting, and we believe that this welding of boiler plates together is a thing of the not distant future. The same may be said of any metal plates. We expect also to be able to weld tubes in the length. I do not wish to be misunderstood. I do not say that we are now able to do this, but I do say that we believe it can be done. We are at present working upon apparatus of a light, movable character, which, without mechanical power, we believe will be powerful enough to weld line wire, such as telephone, telegraph, and electric light and power wires on the line. The apparatus can be put into a waggon and carried to any desirable point. The current obtained from storage batteries forms a portion of the apparatus, and the welding is effected on the line. We expect, also, to weld lead pipe in the same manner, so that any plumber can have a welding apparatus with which he can make one continuous lead pipe in mending and in building, doing away entirely with "wipe joints," and the expense attendant thereon. With an absolutely pure heat, with absolutely perfect means of regulation, with the heating constantly before the eyes of the operator, with a neatness to which ordinary methods cannot at all be compared, with an increased economy of, in all ordinary cases, at least 300 per cent., with absolute safety of handling apparatus—with all these advantages, I do not see why electric welding should not rapidly rise to the dignity of a most important and valuable art.

A paper on the same subject, by Otis K. Stuart, was also read at the recent annual meeting of railway telegraph superintendents, in which he says:

One of the advantages of electric welding, as practised by Prof. Thomson, is the localisation of the heat to the points or point at which it is desired, thus saving an enormous amount of energy which is usually wasted in welding with the forge or flame. So absolutely is the heat localised that pieces of iron 3in. long and an inch in diameter can be welded together, and then held in the hands for some time without any danger of burning, the only heat which is felt at all being that which is conducted along the metal to the hands after the welding is completed.

A further consideration of these facts will demonstrate that it is possible by the Thomson process to weld any metal, including even those which melt at a very low temperature, such as lead, zinc, and tin, and those which melt at enormously high temperatures, as, for instance, iridium, platinum, &c. Of course it goes without saying that we can weld any of the metals used in ordinary manufacture.

It is plain that as the heat is developed so rapidly, a very delicate means of controlling it must be provided, and we are glad to say that we have been able to provide arrangements for this purpose which are almost absolutely perfect—I am inclined to say absolutely perfect for the reason that the control of the current can be made entirely automatic.

We are able to take a bar of inch iron, 4in. in length, raise it to a dull red in 20 seconds, and hold it there for an indefinite period. To increase the heat to a bright red in a very few seconds and hold it there, then to still further raise the temperature to a welding or vapourising point in a remarkably short space of time. This indicates the delicacy of this apparatus, and I would add that no very great skill is required to operate the machine, a boy learning to weld iron and steel with great facility in a week or two. The time required to weld metals depends, of course, upon the power of the apparatus and the skill of the operator. We have made strong and practically perfect welds in half-inch round wrought iron in 6 seconds, in inch round wrought iron in 45 seconds, and so on. Experiments have proved to us that the power required to weld is proportional—or very nearly so—to the area of cross-section of the pieces. This is true of nearly all the metals, though, of course, the relative resistance and welding temperature of the several metals may interfere with this ratio.

For welding small wires, such as telegraph or telephone, and the smaller sizes of electric light and power lines, the power required is very small indeed, the momentum of heavy machinery being more than enough to effect the weld. In this connection I desire to say that we are now working to perfect an apparatus for welding telegraph, telephone, and electric light wire, and lines of pipe on the line. Our experiments in this direction have been successful, and we now think it possible to construct an apparatus which will be capable of being moved about by one or two men, which will make joints in wires correctly and durably, the energy used being supplied by storage battery or batteries, forming a part of the welding outfit. For repair work and in general construction it is our belief that this apparatus will be found very useful and effective. In fact, we hope to do away entirely with the ordinary solder and link joints used at present.

The policy of placing an apparatus on the market has been adopted for the reason that our patents cover not only the apparatus for electric welding, but the art or process as practised by Prof. Thomson. It is hardly necessary to add that by the same process we can solder and braze, and anneal and temper, and do other heating, local or otherwise, which cannot be done economically by present methods. All these operations can be performed with the same apparatus, though, of course, it is better to have machines especially constructed for particular work.

Mr. G. L. Lang, who read Mr. Stuart's paper, stated that he had seen one of these machines in operation when a bar of cast steel and one of copper were welded together. One would suppose that the metal most easily fused would burn away before the other was brought to a welding heat. This is not the case, however, and it is very simply provided against. The current is brought to the bars through clamps which grasp the bars near to the ends to be welded. Where copper and steel are to be welded together, the clamp is placed about 6in. back on the copper bar, where it is only about 1in. from the point of contact on the steel bar. In this case the heat is diffused through a large body of the metal which is most fusible, so that they are both brought to a welding point at the same time. The process is something really wonderful, and promises to revolutionise the ordinary method. The system is now in constant use at the Thomson-Houston factory in Lynn, Mass.

Composing by Phonograph.—Not only are we able to print by electric motor, but by the use of Edison's phonograph printers can now compose with its aid. A compositor on the New York *World* set up 2,000 ems from the dictation of Edison's new phonograph. Two small tubes were fitted to his ears and connected by a large tube with a phonograph. The latter was run by a small electric motor and regulated by a pedal attachment by which the motor could be started and stopped at the compositor's pleasure. The phonograph would talk off a sentence into the printer's ears, and then be stopped until he had put the words in type. This is very probably the most important function that the machine will be used for. One of the greatest difficulties experienced by literary men is the mere manual labour involved in putting down their ideas in manuscript.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

SPECIFICATION.

It is well known that a large number of the more prominent business houses are being gradually fitted for the electric light. It is of the utmost importance in many of these places that a light should be obtained that is not deleterious to the goods which are on view, and this cannot be said of gas. In the early days of electric lighting the work was done in a different manner to what is expected now, but gradually there has arisen, just as in any other engineering work and building work, specifications to which the contractor is compelled to work. These specifications are becoming more and more perfected, and, so far as we have seen them, they are drawn out upon the lines usual in engineering work. A contemporary last week severely criticised a recent specification, but we think, in all fairness, when such an onslaught is made the reader should be in a position to judge for himself, and therefore the whole should be given so that the justness of the criticism upon special portions can be seen.

We have before us this specification for wiring which has lately been issued, and upon which tenders have been sent in, for the wiring of Messrs. Hampton and Sons' premises, and we have given in other pages portions of this specification—in fact, the whole of it excepting the attached schedule—and this in order to give our readers some idea of what is required in the wiring of such places, and also to add our testimony to that of others as to the inadvisibility of some of the clauses. There are certain clauses of this specification which require consideration, and, in our estimation, should not appear in future specifications. It is customary in submarine telegraph work, for example, and in a good deal of engineering work, to make the contractor responsible for a certain time after the work is finished, during which time the owner does not take charge. We believe the usual time in these cases does not exceed a month. It will be seen, however, that in this specification for wiring there is a clause as follows: "If, however, from hidden or from any other causes whatsoever, within the said period of twelve calendar months, it be found that the installation, or any part of it, in any of the buildings is not working efficiently, then it shall be in the power of Mr. Heaphy to refuse to pass such part or the whole of the aforesaid installation until it has been altered and arranged to work efficiently, and to his entire satisfaction, and this notwithstanding that the materials, work, and arrangement had previously met with his sanction and approval." This would seem to imply that the contractor for this work is responsible for its maintenance for twelve months—that is, it should be efficient during that period—and that it should be handed over to his successors at the end of that period also efficient. If this reading is correct, there is not much difficulty in

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the matter, because the price in the contract would be charged for such maintenance, but we doubt, on considering the whole specification, if it can be read in such a way, and that the contractor would in all probability hand over the work at the end of the six or eight weeks allowed him for its completion. It is rather a large tax to provide for when hidden or any other cause whatsoever is to be taken into account. Suppose, for example, by some unfortunate means there was to be a fire, would the damage caused by this fire have to be replaced by the contractor, and would this form a part and parcel of his contract? It may be said that electrical engineering differs from other classes of engineering, and that some faults are very slow to develop and may not develop themselves within the short space of one month. We cannot help thinking, in the case of electric light engineering, that if faults do not develop in such a period they cannot be of very great importance.

There is another clause to which we should like to call attention, although this follows the lines of almost all engineering specifications, and relates to the question of arbitration. A good deal has been written and said on the subject, but opinions are divided, and the clause appears quite as frequently as it is altered. It will be seen from this specification that Mr. Heaphy is acting for Messrs. Hampton and Sons, and the contractor is to be paid 80 per cent. of the contract price within a week of receiving Mr. Musgrave Heaphy's certificate. So far there is nothing to complain about. It is, however, different when we come to the following clause: "In the event of any dispute or question arising between the contractor and Messrs. Hampton and Sons, or their representative, on any matter whatsoever connected with the work, or the interpretation or meaning of any part or the whole of this specification at any time during the progress of the work, or after the work has been completed, or after the before-mentioned twelve months has expired, then such question or dispute shall be referred to Mr. Musgrave Heaphy to arbitrate upon and decide, and his decision shall be accepted as final and conclusive by both parties."

Of course we all know that the engineer may endeavour his utmost to be perfectly unbiassed in case of dispute, and may be so, but it would be better, on the whole, if the arbitrator was in every case a perfectly independent person, who had had nothing whatever to do with the work in dispute. We have often had to maintain this opinion in the case of engineering specifications, and we certainly do not see why a specification relating to electrical engineering should cause a change of opinion. The great aim is to get the work done in as perfect a manner as our knowledge at the present moment allows it to be done, and it must be admitted, from the experience of the past few years, that the knowledge obtained in electrical work during twelve months may be of such a character as to hardly admit of an interested party viewing clearly what was absolutely just and right twelvemonths beforehand. We do not altogether agree with our contemporary in its remarks about inspection in connection with fire offices. It is well known that somewhat rigid inspection is absolutely necessary, and although it may not have been imposed in the early days of gas, the pity is that it was not so imposed. The gravest difficulties are likely to arise if latitude of opinion is permitted as to the stringency of this inspection. We ought all to be agreed, not because it happens that Mr. Heaphy was first in the field, but on principle. Just as one swallow does not make a summer, so will not the change of one or one hundred individuals of their policies from one office to another affect the question. The moment any licence is permitted to contractors, so soon will every detail of the arrangement be open to alteration, and one office may permit change here and there till the collective changes, if admitted into any one installation would make it very far from safe. We must have safety combined with certainty.

CORRESPONDENCE.

THE INSTITUTE OF MEDICAL ELECTRICITY.

To the Editor of The Electrical Engineer.

Sir,—As you and many of your readers have expressed considerable interest in this institute, the directors would feel obliged if you will allow me an opportunity of making known in your columns the reason why the opening of our London establishment has been so long delayed.

In the end of March last the directors proceeded to the appointment of medical officers, and, after consultation with the medical visitors, selected two distinguished London physicians well known in scientific circles for the great attention they have long given to the medical applications of electricity.

These gentlemen, however, happen to be, one a fellow, and the other a member of the Royal College of Physicians, and though they were personally willing, unexpected difficulties of a purely professional character have been encountered in connection with their acceptance of the post offered to them. The directors hoped at one time that a memorandum on the subject which was signed by ten of the leading men in the electrical profession, all being members of the council of the Society of Telegraph-Engineers and Electricians, and six of them being also fellows of the Royal Society, would have aided in removing these difficulties, but I regret to say that they are still unsurmounted.

I need hardly assure your readers that this unfortunate *contretemps* will in no way alter the character and tone of the institute; but that, being more than ever convinced of the need for such an undertaking, and of the good that may come from it, the directors will proceed with a medical officer who is not a member of the Royal College of Physicians.

These premises are now being fitted up rapidly with all the necessary apparatus, and the directors hope that they will be ready to receive patients in September. They think it expedient, however, to defer the formal opening until October, when they hope to gather their friends around them.—Yours, &c.,

H. Newman Laurence, Managing Director.

Institute of Medical Electricity, London, S.W.,
August 11, 1888.

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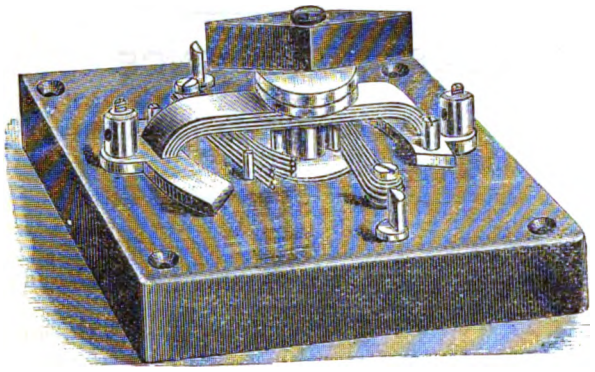
QUICK BREAK SWITCH FOR LARGE CURRENTS.

A modified form of Messrs. Woodhouse and Rawson's well-known "G" switch has lately been brought out, which appears to possess many advantages. The handle and contact-brush are not rigidly fixed together, although mounted on the same centre-pin; but two studs fixed in the handle-plate above the brush work in two segmental slots stamped out of a disc attached to the upper side of the brush, and these are so arranged that as the handle is turned in the "off" direction, the brush is driven by it nearly to the edge of the terminal contact-plates, when it is taken charge of by two sets of springs which effect a very rapid and complete break. These sets of springs each consist of several springs of steel wire formed up into "lock-spring" shape, and all mounted on one stud, the free ends bearing against a pin on the under side of brush. The plates of vulcanised fibre, which, in the older form of "G" switch, were fitted up for the brush to rest on when off the contact-plates are here done away with, so that the brush flies off the contact-plates quite clear of everything, and well above the slate base on which all the work is mounted. The necessary pressure between the brush and contact-plates is produced by a triangular spring washer in a recess underneath the slate base, which draws down the centre pin carrying the brush. The combination of the contact-brush of thin plates, the spring washer underneath, and the two sets of multiple springs, produce a particularly "sweet" motion; and the contacts made by the brush are evidently as perfect as can be desired. The good character of the free and quick break is also due to the combined effects of the very flexible springs and the spring washer underneath.



Messrs. Woodhouse and Rawson's "G" Switch.

The Woodhouse and Rawson Electrical Supply Company, Limited, state that these switches are made to carry 5, 10, 20, 30, 60 and 100 amperes, the three smaller sizes being rather different in construction from the others; and that very shortly switches on this design, to carry considerably larger currents, will be in the market.

We may add that these quick-break "G" switches are, like the older pattern, strongly made, and amply large enough for the currents they are intended to carry.

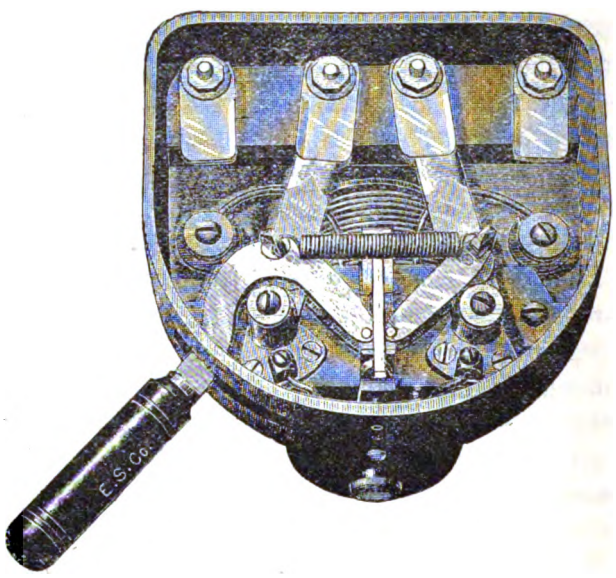
AUTOMATIC GROUND SWITCH.

An arc light circuit or a series incandescent circuit very seldom consists in a single straight run, but usually consists of a series of loops from the main line covering the area lighted. A ground connection on one of these loops will, if there is the slightest tendency to a ground connection at any other position, however distant, destroy the insulation, and put out all the lights, possibly also doing damage by fire.

An automatic ground switch is being introduced by the Electrical Supply Company, of Chicago, which is designed for use in high-tension series circuits to act automatically so as to cut out the damaged loop immediately a ground connection develops itself, thus preventing damage in this section, and at the same time allowing the lamps in the remaining sections to continue alight. The automatic action is so perfect that no spark is seen even at the point of ground. This has been demonstrated by coupling the switch experimentally at the station, and making intentional ground connection. The insulation of the switched-off loop from the active line is, moreover, quite perfect, and repairs can go on without delay or danger. One of the principal advantages is that the switch indicates which section is defective, and much searching for the ground is obviated, as well as the awkwardness of a total stoppage of the circuit.

In the illustration a spring will be seen which connects the two outer extremities of a knee and toggle-joint system of levers which are disconnected from the switch arms, the joints of which are brought by the direction of the handle almost exactly into line, and in the best position to easily resist the action of the spring. A catch is provided to hold the system of levers in this position; this is released automatically on development of a ground. This catch cannot be jarred out of position no matter how severe the concussion. The contacts are double-lipped, and offer no resistance to the passage of the current. The two outer terminals at the top are the loop-line terminals; those sunk in the body of the switch immediately below them are the main line terminals. The handle is for reconnecting the loop line after repair.

The body of the switch is entirely out of circuit, and is made as far as possible moisture proof, being covered thoroughly with a special heavy coating of gutta-percha and japan. The interior portions are thoroughly insulated and covered with a preparation of asbestos, conforming



New Automatic Ground Switch.

throughout with fire office regulations. The small button shown is for the purpose of cutting off the loop by hand by merely pushing it. A padlock attachment, not shown in the cut, is also provided by means of which the switch may be locked when cut out, so that no one can succeed in throwing it on while men are working upon the loop.

COPPER STEAM PIPES FOR MODERN HIGH-PRESSURE ENGINES.*

As might have been expected, the disastrous explosion of the main steam pipe and consequent loss of life that occurred on board the Royal Mail steamer "Elbe" in September last, and a similar explosion on board the North German Lloyd's mail steamer "Lahn," have led to investigations as to the cause of these accidents; and, further, the whole subject of the manufacture of copper steam pipes has been considered generally, and experiments carried out with the view of ascertaining the behaviour of the different kinds of commercial copper under various conditions of treatment and at various temperatures. A

* Paper read at the thirtieth session of the Institution of Naval Architects at Glasgow, July 25, 1888, by Mr. W. Parker, chief engineer surveyor to Lloyd's Register of British and Foreign Shipping, member of council.

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summary of the investigations and the results of these experiments will not, I think, be without interest to these meetings.

The s.s. "Elbe" was built in 1870 by Messrs. J. Elder and Co., and fitted with ordinary compound engines. In February of last year she was placed in the hands of Messrs. Oswald, Mordaunt, and Co., of Southampton, for the purpose of being fitted with new boilers to work at a pressure of 150lb. per square inch, and of having her compound engines converted into triple-expansive ones. This work was completed, and the vessel was running her official trial in Stokes Bay, when the main steam pipe abreast of the after boilers burst, and all in the stokehole at the time, numbering eleven persons, were killed by the sudden outrush of steam.

The s.s. "Lahn" is a new vessel built by the Fairfield Shipbuilding and Engineering Company last year. In March last, while on her second voyage across the Atlantic, her steam pipe burst in a somewhat similar manner, but the loss of life was less in this instance than in the case of the "Elbe."

It was natural to suppose that the bursting of copper steam pipes, such as those of the "Elbe" and the "Lahn," would be found to be attributable to defective workmanship or material, and that due care had not been exercised in the manufacture of the pipes; but these investigations go to show that elements of very serious danger enter into the ordinary methods of making brazed copper pipes, especially when intended for high-pressure steam.

The steam pipe which exploded on board the "Elbe" was 9⅜in. in diameter inside, and 6ft. 6in. long, the thickness of the copper was ·276in., corresponding to No. 2 imperial wire gauge; it was brazed in the usual manner, with a lapped joint, and to all appearance seemed a well-made pipe. The copper had been obtained from a first-class manufacturer in Birmingham, and analysis has shown it to be chemically of the best quality.

The pipe itself had been tested by hydraulic pressure on two occasions, once for the satisfaction of the builders to a pressure of 300lb. per square inch, and a second time by the owner's representative to 350lb. per square inch. These tests had been sustained in a perfectly satisfactory manner, and, so far as could be judged, every care had been exercised by the makers to produce as good a piece of workmanship as possible.

Test-pieces were cut from the exploded pipe, and the copper away from the locality of the brazing was found to have an ultimate tenacity of 33,000lb. per square inch, with an elongation before fracture of 33 per cent. in a length of 5in., so that the bursting pressure for this pipe, in its cold state, should have been about 1,940lb. per square inch, being thirteen times the working pressure, or, taking the actual thickness of the copper at the fracture as measured after the explosion, and which was found to be $\frac{3}{16}$in., the pipe should still have borne an ultimate pressure of 1,220lb. per square inch, or 8·8 times the working pressure.

In order to ascertain the actual strength of the portions of the pipe adjacent to the exploded part, a piece of the pipe, about 30in. long, was cut from the portion still intact of the length which exploded, and two other similar pieces were prepared from the next adjoining length of pipe. These short pieces were fitted with flanges and tested to destruction by hydraulic pressure, and in each case the pipe burst in exactly the same way, namely, through the copper near and parallel to the brazed seam, commencing near to one of the flanges.

The pieces taken from the same length where the explosion had occurred gave way under a hydraulic pressure of 780lb. per square inch, the fracture exhibiting a granular and in part a discoloured appearance.

Of the two pieces cut from the next adjoining length of pipe, one burst at 600lb. per square inch with the same granular and partly discoloured fracture, as if the metal had been injured or partially cracked through during the operation of brazing; and the other burst at 1,140lb. per square inch, the fracture being granular but not discoloured.

This great diversity in the bursting pressures for pipes of the same dimensions and material, and the similarity in the character and position of the fracture in each case, together with the fact that the pressure at which the strongest of these lengths burst was still not more than five-eighths of the calculated bursting pressure, seemed clearly to indicate that the material had been injured in the neighbourhood of the seam by the operation of brazing.

Some very careful experiments to ascertain the effect of increased temperatures upon sheet copper were made by the Franklin Institute in America as long ago as 1837, when strips of copper were pulled asunder in a properly designed machine at temperatures ranging from 122deg. to 1,332deg. Fahr., and, as will be seen by the following table, the falling off in strength as the temperatures increased was very considerable, until at 1,332deg. Fahr., or a bright red heat, the tenacity was *nil*.

Experiments made at the Franklin Institute, America, in connection with an investigation into the strength of boilers.

Temperature above 32deg.	Diminution of strength.	Temperature above 32deg.	Diminution of strength.
deg.		deg.	
90	0·0175	660	0·3425
180	0·0540	769	0·4389
270	0·0926	812	0·4944
360	0·1513	880	0·5581
450	0·2046	984	0·6691
460	0·2133	1,000	0·6741
513	0·2446	1,200	0·8861
529	0·2558	1,300	1·0000

These results were substantially corroborated by a series of experiments made by Dr. Kirk and myself after the "Elbe" explosion.

From the table it will be seen that at 360deg. Fahr., or the temperature of steam of 150lb. pressure, copper has about 15 per cent. less tensile strength than when cold. But allowing for this falling off in tenacity, the steam pipe of the "Elbe" at 150lb. steam pressure should still have had a factor of safety of 8½.

Carefully examined through a microscope, the difference in the structure of the copper in the neighbourhood of the brazing where the exploded pipe and those afterwards tested gave way and the structure in that part of the pipe away from the brazing was very marked, and was clearly to be ascribed to the heating of the copper during brazing.

Test-pieces were cut from the pipe near to the brazed seam where the rent had occurred, and it was found that whereas the copper from other parts of the pipes showed a tenacity of 33,000lb. per square inch with an elongation of 33 per cent. in 5in. and 59 per cent. contraction of area as recorded above, in these pieces the tenacity was only 24,418lb. per square inch, the elongation only 4·6 per cent., and the contraction of area at the fracture only 13 per cent. This result was amply confirmed by testing other strips cut from the same locality; they each showed that the copper near the brazing had lost its ductile qualities and much of its tenacity.

In order to obtain further information on this point, the following experiments were made:

1. A strip of good copper was cut from a sheet and bent and broken cold.

2. A similar piece was raised to a heat above that necessary for brazing, when it became red, short, and broke with its own weight.

3. A piece was raised to the same bright heat as No. 2, allowed to cool, and then broken cold.

4. A piece was raised to the above brittle heat, at which it was partially broken through, then allowed to cool, and the fracture completed when cold.

The appearances of these fractures were very interesting; the first had the fibrous silky appearance of a good copper; in the second piece the fracture was coarse and blackened by the heat; but the third specimen seemed to have almost completely regained its tenacity and ductility on cooling, the copper in its normal state having a tenacity of 35,212lb. per square inch with an elongation of 40 per cent. in 5in., and a contraction of area at the fracture of 39·9 per cent.; and the third specimen, although it had been raised to a blistering heat, was, when cold, found to have a tenacity of 31,337lb. per square inch, with an elongation and contraction of area at fracture practically the same as the

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normal copper, which would appear to show that, although the copper should be overheated in brazing, if not otherwise injured, its qualities will be substantially regained on cooling.

The fourth piece was partially broken while hot, and the appearance of that part of the fracture was discoloured by the action of the heat, but the part that was allowed to cool had its ductility restored, and afterwards broke with a bright fracture. This experiment was repeated a number of times, with similar results, and the fractures corresponded exactly in appearances not only with that of the exploded pipe, but also with those of the other pipes which were experimented upon, and which burst at pressures of 600lb. and 780lb. per square inch respectively.

The only difference in these fractures was the depth to which the partial crack, as shown by discoloration, had extended.

In this manner the exact appearance of the fractures of the exploded pipe, and of those experimental pieces which burst at the low pressures, was reproduced artificially by burning the copper and treating it in the way described.

From this it will be seen that, should a copper pipe be overheated during the brazing operation, and seeing that the metal becomes perfectly brittle at not much above the brazing heat, the pipe might accidentally be cracked when in this brittle condition; and, although the section of metal still remaining intact might be sufficient to sustain the cold water test pressure, yet the hot steam and accompanying strains might develop and deepen the crack, and the pipe ultimately give way at the working pressure.

This I consider to be the true explanation of the explosion of the "Elbe's" steam-pipe, and also that of the s.s. "Lahn."

A serious element of danger is thus shown to exist in the present practice of brazing large, heavy copper pipes intended to be subjected to the high pressure now so common. It is generally admitted that welds or brazed joints in any material must possess certain elements of uncertainty, and the above experiments show this uncertainty to be greatly increased in the case of copper worked over a fire.

How to eliminate these elements of danger becomes an important question. Various alternatives suggested themselves, as, for instance, that the copper might be worked cold and the joint made by a riveted seam, that brazed pipes might be served with wire or have strengthening bands fitted at short intervals (both of which systems I find are now resorted to), or that steel pipes might be used, the seam being riveted.

While these points were under consideration, I had brought to my notice by Mr. W. Elmore a method of making copper pipes of any required diameter, length, or thickness by electro-deposition, and I was instructed by the Committee of Lloyd's Register to proceed to Mr. Elmore's works and witness the operation of making these pipes, with a view to reporting thereon for the information of the committee. The process is briefly as follows: A mandrel is surrounded by ordinary unrefined Chili bars arranged upon strong supporting frames in a depositing tank of sulphate of copper, and the copper is dissolved or decomposed, as will hereafter be explained, and is deposited in the form of pure copper on the revolving mandrel, leaving the copper in the form of a shell or pipe, of any thickness required, fitting closely to the mandrel. When the required thickness has been deposited, the pipe and mandrel are exposed to the action of hot air or steam, then the copper expanding more than the iron admits of the mandrel being drawn, leaving the copper in the form of a pipe, without a seam, perfectly round and true both internally and externally; or the pipe may be expanded or made larger by rolling or other mechanical means, and then the mandrel withdrawn.

The deposition of copper by electricity is not at all new. It has been in use for years for electrotyping purposes, and for separating copper from its impurities, and particularly for extracting gold and silver. But copper thus refined is wanting in cohesive properties, and without some means of increasing its density, which would give to it, at the same time, both tenacity and ductility, it would in such a form be useless for mechanical purposes. The ingenious manner in which this difficulty is overcome by the present process constitutes its most important feature.

(To be continued.)

THE SOLUTION OF THE MUNICIPAL RAPID TRANSIT PROBLEM.*

BY FRANK J. SPRAGUE.

(Concluded from page 128.)

In estimating the road expenses, more than liberal allowance is made, but in a new enterprise it is safe to err on this side rather than attempt to claim for a system advantages which will not in practice be borne out. The expenses are then as follows:—

Oil, grease, and waste	$4.50	
Brushes	3.00	
Trolleys	2.80	
Material		$9.50
Three mechanics and one helper for thoroughly overhauling motors once a week, making repairs, adjusting brakes, &c.	7.90	
Four inspectors, two day and two night, for oiling machines and looking after brushes	7.50	
Two night inspectors to thoroughly inspect motors after cars are laid up and see that all bolts, nuts, and connections are tight, and that everything is in good working order for the morning run	4.00	
One winder and helper for making any repairs which may be necessary and any testing which is required	3.50	
Two linemen	5.00	
Labour		27.90
Depreciation on car work at 15 per cent.	18.00	
Depreciation on line work at 10 per cent.	4.00	
Depreciation		22.00
Total road operating expenses		$59.40

or $1.98 per car, making 80 miles.

The total motive-power expenses, both in the central station and out on the road, would not then exceed 3dols. 46c. per car making 80 miles, or 4·32 cents per car mile; and this includes everything except the executive and salary expenses, taxes and insurance, and is less than 40 per cent. of the cost of operation by horses with the same number of cars and under the same conditions.

But the showing is even better than this, for another fact is to be noticed, and it is an important one from an economical point of view. For example, 20 cars on duty for about 18 hours make a mileage of from 1,500 to 1,800 per day; and if it were not for the fact that the schedule requires them to operate part of the time on a single track with insufficient turnouts, they could make 1,800 or 1,900 steadily—this notwithstanding the fact that the speed is limited by municipal regulations. Many of the cars often run 90 to 100 miles. The same mileage and intervals made by twenty electric cars could not, under the circumstances, be made by anything less than twenty-five horse cars of the same size, and electric cars probably carry in the aggregate just as many passengers. It follows that to get the same service with horses not only would the number of cars have to be increased, but likewise the number of horses, conductors, and drivers. The same mileage performed by horses without these cars and grades would require a stable equipment of not less than 300 horses.

With the mileage which is now made there is an actual saving of about 125dols. per day in the motive power expenses as against operation by horses. It is hardly necessary to point out that this would pay a good interest on a pretty large investment. The capacity of the road to economically carry passengers has been made so apparent that the old City Railway, which was operated by mules and has about 13 miles of track and 50 cars, has been bought up and is to be equipped with motors operated from the same central station. A third line will probably be added, and in the near future every street car, to the number of 100, in Richmond, Manchester, and Virginia, will be electrically operated from one station.

* Read before the American Institute of Electrical Engineers, June 19th, 1888

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From this same station is operated a power and light circuit.

A good idea of the operation of the system may be obtained from the following weekly table, taken from the records of the railway company up to the present date:

Week ending.	Number of cars put out for regular service.	Average number of cars out per day.	Miles per week.	Average miles per day.	Average miles per car per day.	Passengers per week.	Average passengers per day.
Feb. 8	72	10·3	2,632	376	36·5	18,764	2,680
15.....	48	6·9	1,211	173	25·2	6,688	956
22.....	77	1·0	2,604	372	33 6	16,504	2,358
29.....	91	13·0	4,039	577	44·4	21,944	3,135
Mar. 7.. ...	94	13·7	5,047	721	52·6	25,063	3,580
14.....	86	12·3	5,313	759	61·8	20,897	2,985
21.....	99	14 1	6,916	988	69·9	30,357	4,337
28.....	113	16·1	8,621	1,232	76·3	27,076	3,868
April 4.....	118	16·9	8,351	1,193	70·8	28,260	4,037
11... ..	133	19·0	10,089	1,441	75·9	36,683	5 240
18.....	133	19·0	10.583	1,512	79·6	40,090	5,527
25.....	135	19·3	10,895	1,557	80·7	39.040	5,777
May 2	137	19·6	11,309	1,616	82·4	45,350	6,479
9.....	140	20 0	10,832	1,548	77·4	51,648	7,378
16... ..	176	25·1	11,563	1,652	65·8	58,598	8,371
23.....	186	26·6	12,128	1,733	65·2	55,163	7,380
30.....	194	27·7	12,789	1,830	66·1	57,519	8,217
June 5.....	189	27·0	14,154	2,022	74·9	52,820	7,546
13.....	187	26·7	14,649	2,093	78·4	59,219	8,459
20.....	181	25·9	14,371	2,053	79·2	70,965	10,138
Total.....	.....	.....	178,096	.....	.....	762,648	.....

Having thus seen what is possible on a street railway, let us briefly consider the application of electricity on a larger scale.

The failure of the elevated railroads in this city to meet the issue of rapid transit is in no way more forcibly illustrated than by the number of plans which have been brought forward for discussion. No less than eleven have presented themselves, several of which have features in common and claim similar routes, and I will but very briefly review them.

The Beach Pneumatic was merged into the Broadway Underground, and this in turn into the New York Arcade Railway Company, and it is now familiarly known as the Arcade. They propose to run from the Battery, thence to Broadway and Madison-square, with four tracks, the two centre being express tracks, with stations one mile apart, and the two outer tracks for way traffic. Thence the route extends to Fifty-ninth-street, by Broadway, and to the Harlem River by Madison-avenue, with an additional route up the west side of Central Park by the Boulevard, or some other avenue, and into the annexed districts. Branches are proposed to connect Broadway and Madison-avenue on Twenty-third-street, and the two branch roads on Forty-second-street.

The Underground Railway Construction Company has pooled the issues of the New York District, New York Underground, and the Metropolitan Junction Company. The route of the first is similar to that of the Arcade, and runs from the Battery to Broadway and Madison-square with four tracks; thence up Broadway to Fifty-ninth-street, and up Madison-avenue, over the Harlem River to some point near Jerome Park. Branches are also proposed from river to river on Twelfth and Twenty-third streets. The New York Underground road proposes to run from the City Hall Park east to Broadway, through Centre and Mulberry streets to Lafayette-place and Fourth-avenue at Union-square. Thence by two lines to the Grand Central and Broadway and Fifty-ninth-street, up the Boulevard to Kings Bridge, the main line continuing under Madison-avenue to the Harlem River, and by a loop to Kings Bridge.

The Metropolitan Junction Company proposes to connect with the two last-named in the annexed districts, and then run over the Hudson by a bridge at Washington Heights, connecting with a tunnel through the Palisades.

The City Railway Company proposes to begin at South and Whitehall streets, crossing Broadway below Rector, running between Church-street and College-place, Sixth and Seventh avenues to Fifty-ninth-street and the Boulevard. The line would then run up the west side of Central Park, crossing the Harlem River above High Bridge, terminating in New Rochelle. Branches are proposed for the principal ferries on both rivers, the Post Office and Grand Central Station. The roadway is intended to be 50ft. wide and 12ft. below the street surface; it is to have four tracks, two way and two express. It differs from the other underground railways in that instead of taking the street lines it proposes to purchase the necessary property and erect buildings over the line of the road, which are to be rented for sufficient to pay the bonds of the company. The road thus running through the basements, so to speak, of the buildings, and crossing the streets by tunnels, becomes a covered roadway instead of an open one.

The Terminal Underground Railway Company proposes a four-track underground railway from the City Hall along the proposed Elm-street improvement to the Grand Central Depot.

The Metropolitan Transit Company proposes two elevated steel structures, one on Broadway, between Chambers-street and Forty-third-street, connecting with the Grand Central Depot, and the other on the west side, following the line of the water front to Gansevoort Market, thence up Tenth-avenue and the Boulevard to Kingsbridge.

The plant proposed by Heman Clark is one of the most radical. He proposes a four-track tunnel, beginning near Fleetwood Park, cut in solid rock 150ft. below the surface, coming down about 100ft. west of the line of Broadway to the Astor House, where it would connect with two two-track branches, one going under the North River to Jersey City and Newark, and the other under the East River to Brooklyn and Prospect Park. Passenger stations would be at the foot of shafts sunk every two miles, and freight stations at intermediate shafts where freight pockets would be tunneled. Large elevators would be used for handling the passengers and freight.

All of these schemes have their good and bad points which I do not propose to discuss here; but whichever is successful, they hope to use electric motors for propulsion. Now, whatever we may claim for electrical motors, it would be folly to attempt the handling of the traffic of such a road without full knowledge as to the character of the work which has to be performed, and a perfectly definite idea of the system of train dispatching which will best meet the wants of the public, and, at the same time, preserve an effective and economical system of operation. To fully consider this, let us briefly review the work which is being done on the elevated railroads—for example, on the Third Avenue line.

This is eight and a half miles long. Grades vary from eight to 105 feet to the mile. The level stretches amount to about one-third of the whole distance, and this includes the stations. On the 17 miles of single track there are 52 stations. In the busy hours there are no less than 63 four and five-car trains on the tracks. These trains, weighing from 80 to 95 tons, make the half trip in 42 minutes, including stopping at 26 stations, and discharging and taking on passengers, or at the rate of about 10 traffic miles per hour. The work of the engines may be divided into three parts—viz., overcoming the train's inertia, lifting the train on the grades, and traction—and the maximum is at least seven times that necessary for traction at mean speed on a level. Three times in every mile this weight of 80 to 95 tons must be started from a dead rest, raised to a speed of twenty or more miles an hour, and brought to rest in about eighty seconds. The engines have to be run with 130 pounds boiler pressure, and have a capacity of 185 h.p. Fifty-nine per cent. of the power on a round trip is used in starting, 24 per cent. in lifting, and 17 per cent. in traction, and the average power developed per minute per round trip, including stoppages, is 70·3 h.p.

The traction necessary to handle these trains is obtained by a locomotive weighing 22½ tons, of which only fifteen are carried by drivers 5ft. apart. With an engine and the forward trucks of one car between two girders,

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we have a weight of nearly 1,500 pounds per running foot. The present weight of engines is not sufficient to properly handle these trains when the tracks are in a slippery condition, and it is not wise to increase it. It is absolutely necessary to keep up the high character of the engineering work of this road, and every consideration of business prudence and public safety will permit of no laxity in this direction. Yet these locomotives have done wonderful work. Although on duty for twenty hours, with steam admitted to the cylinder for six hours only, with an average horse-power of only 38 per cent. of the maximum, and with all the incidental losses of steam, they develop a horse-power with less than a total expenditure of 6·2 lb. of coal per hour; and the coal expense alone is only about 1dol. 15c. per round trip, or 2½ cents per train station. The operating expenses are 62 cents per train mile, or allowing an average of four cars per train, 15½ cents per car mile, and this includes everything.

The percentage of expenses of operation and maintenance for the whole Manhattan system may be roughly expressed as follows:

Motive power	42.8
Maintenance of cars	5.4
Movement of traffic	38.4
Maintenance of way	8.2
General expenses	7.2
Total	100.0

The coal alone costs over 700,000dols. per annum, which is more than the wages of the engineers and firemen, but it is only about one-sixth of the total operating expenses. Hence there are other reasons than merely a saving in coal which must be urged in favour of an electric system as against a steam system.

Generally speaking, the real needs of rapid transit are not best subserved by the handling of long trains from a single tractive-engine True, the conditions of service on the elevated railroad, the crowded condition of the track, and the great cost of operating independent steam-engines makes it impracticable to work with small train units there. But the fact remains that the effective length of train which can be operated by any system is limited; that this limit has already been reached on the elevated railroad, where only one-sixth of the weight is now effective for traction; and that the smaller the units the less the momentum of the train, and the easier it is to quickly and efficiently handle it, and the less will be the liability of, and danger from, any derangement of the brake apparatus. Furthermore, the thrust of the moving weights on the grades, the vibration due to the shifting of the weight along the girders, the tensile, shearing, and crushing strains on the structure are all materially increased by the use of a heavy locomotive at the head of a long train.

But since we must endeavour to meet all conditions of engineering, we must try to meet that one which requires the operation of a heavy train by a single-motor car. In this case, I deem it advisable to make the motor car of about the same size as the cars which form the train, equip both trucks, and thus spread the weight used for tractive purposes over a larger distance. We have now partly constructed a 300-h.p. motor equipment of this character.

This car, whose general external dimensions are similar to those of the regular elevated passenger coach, differs in its construction in many important details. The front and rear platforms are enclosed, and about 10ft. at each end of the car—that is, the space over the trucks—is partitioned off and reserved for the use of the motor man. The middle space has side entrances, and is fitted for passenger accommodation. At each end of the car the floor-framing is raised about 12in. for a distance of about 10ft. from the end, and the car body is carried on two very strong and heavy special iron trucks mounted on 42in. wheels fitted with 5in. steel axles. Each axle has an independent movement, and is driven by a tandem motor, centred upon the axle, which bears a part of the weight. The motor is also carried by heavy compression springs hung from the truck, by means of which as much of the weight of the motor as is desired can be thrown on to the boxes. Each motor, which is of about 75 h.p. normal capacity, has two armatures, each of which is connected to a fixed and adjustable gear on the axle, the ratio of the gearing being about one to three. These motors will have one brush on each commutator, and that will be a top brush. Each motor has directly over it, in the engineer's room, trap doors fitted with heavy glass panels, which allow the machines to be seen at all times, and through which the machines can always be reached. The controlling devices and switches are all duplicates, and the car can be handled from either end. The car and the trucks are completed; the motors are well under way. The car will be capable of exerting a tractive strain of at least 20,000 lb.—more than double that of the present locomotives.

But this is not the ideal method of traction.

By a system of electrical propulsion, the power can be distributed underneath the cars, every car, or every two if need be, being a unit; and, although I do not think it advisable, arrangements could be made for propelling a large number of cars under simultaneous control. By distributing the power under the car, the whole weight of the car and passengers can be made effective for traction. This will enable the cars to be started more promptly, brought to speed more quickly, and stopped in shorter intervals increasing the mean rate of speed for a given maximum, or *vice versâ*, reducing the maximum for a given mean rate. By making cars individual units of locomotion, the intervals between trains may be made one-fourth or one-fifth of the schedule which must exist where four or five-car trains are used. It may be said that this will increase the number of employés that are necessary. This is true, but it will increase the number of passengers who, both day and night, would make use of the system in such a ratio as would make this increase of expense insignificant.

Let us consider a possible system which would go a long way towards solving the question of rapid transit. I will briefly point out its features. It would have four tracks, extending from the Battery up Broadway to Twenty-third-street, thence diverging in two divisions, each still with four tracks, one along the line of Madison-avenue to the Harlem River, and terminating near the Jerome Park district, the other following Broadway, and running up the line of the Boulevard and Tenth or Eleventh avenues. Two tracks would be reserved for express traffic, with stations a mile apart, and two for way traffic, with stations every third of a mile, and every third way station corresponding with an express station. The tracks would be arranged in two tiers, the express tracks being the lower. The entire system would be lighted, ventilated, and operated by electricity, to be supplied from four stations on the water front—one at the Battery, one at East Twenty-third-street, one at Madison-avenue crossing of the Harlem River, and one on West One Hundred and Twenty-fifth-street; the stations to be operated by compound condensing engines in three units, connecting directly to large, slow moving multipolar dynamos, two engines being of sufficient capacity to handle the demand made upon any station; trains to be operated with one, or at most two car units; motors to be on the trucks of one car, centred on the axle, and with one reduction of gearing, express speed to be 30 miles an hour, and way trains to make 12 traffic miles per hour; the current to be delivered to the cars by an overhead system with underneath contact, the contact wheel to be carried on the car, supported over the centre of the truck and trending a little abaft it. Freight pockets at the level of the way track could be run under the cross streets at express stations. Track to follow a line of grade of not more than 25 per cent.; access to stations to be by stairways, and where there is any material difference between the street level and the track, by hydraulic elevators, operated from constant pressure tanks kept supplied automatically by electric motors. Freight trains to be run on way tracks.

Supplementing this system should be a line of surface cars, likewise operated by electricity from the same general source. In the heart of the city these can be operated from a conduit, or by the storage battery, and in all the suburban extensions by the overhead line system.

The objection of loss in transmission and recovery has been raised as against an electric system, and also the question of breaking. These are easily met.

We have systems of electrically breaking a train by the use of its motors, which consists in converting them into dynamos, deriving their driving power from the train, and

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using up its energy by converting it into electrical energy, which can be used in a variety of ways. In a storage battery system the energy of the car can be made to partially recharge the batteries on a down grade, and in stopping. In a direct supply multiple-arc system, operating a large number of cars, this power of being able—at will — to convert the energy of a moving train into electrical energy delivered to the line by the same apparatus which controls the speed and power of the train is of exceptional importance. In a double track system the energy given to one track may be communicated to the other just as efficiently as along itself. In fact, in the entire electrical system every part is mutually connected, and there is a bond of union between the different trains far more perfect and effective than any mechanical connection could be. The up-grades on one track being equal to the down-grades of the other, it is evident that the total up-grade of a system is equalised by the down-grade thereof. If, then, energy is expended in getting under way and climbing up-grades, and a large proportion of this can be recovered in stopping and in running down grade, it is evident that the total initial energy required would be that necessary to remove the trains continuously on level grades, with a percentage for loss in conversion and reconversion added. The more train units which are operated, and the more frequent the stoppages, the more marked is this advantage in an electric system.

I some time since made a number of determinations of a system of the equipment capacity of the Third-avenue Elevated, in which I found that about 40 per cent. of the power could be saved by this system of breaking, where every motor coming to a station or running on a down grade is made a generator which is helping to supply the current needed to operate the remaining trains.

Instead of the current being all supplied by a main generating station at one or two points, it would be supplied from nearly as many moving stations along the line as there would be trains slowing down or running on a down grade. In fact, the loss of the two conversions and one transmission would be more than counterbalanced, and consequently the original h.p. at the central station would be no more than the aggregate net h.p. now developed on the entire line, and this is only about 38 per cent. of the total capacity of the engines. With any given potential and losses on the line, the main conductor would be very much smaller. Not only on the line, but at the central station would be a saving effected; for in a system of the capacity of that which we are considering this saving on lots, buildings, boilers, engines, dynamos and fittings would be not less than 400,000dols., and there would be about 40 per cent. saving in the coal, labour, depreciation, and incidental expenses of the central station.

Another method of using the motors for braking purposes is to break the connection from the line and reverse the machine through a local circuit on the train, varying either the local circuit or the circuits of the machine. While in this position of braking, if the local circuit is opened and the line connection made, the machine would be instantly reversed.

Elaborate experiments were made by me nearly two years ago on the Thirty-fourth-street branch of the New York Elevated Railroad, in which these questions of gearing, of mounting the motors on trucks under the car and handling the car without shoe-brakes were very thoroughly studied. There this method of braking was shown to be under the most perfect control. When desired, the braking could be made so sudden as to cause the wheels to have a continuous skidding rotation, not such a skidding as is caused when an air brake is put on too sharply, but a rotating slip, which is just enough to relieve the armature when the strain on it reaches the point determined by the co-efficient of adhesion on the rails.

This is the ideal method of braking, because fixed skidding and flat wheels are an impossibility, and the wheels will turn until the train comes to a dead stop, although, where the breaking power is put on too suddenly and exceeds the grip of the wheels, they will relieve themselves by slipping just enough to keep the braking at the maximum limit. A train so governed can be made to creep down the maximum grade of a road at a snail's pace, and in an emergency such a car, running at 21 miles an hour on a down grade, has been stopped and reversed within 90ft.

When an electric motor is reversed its action is cumulative, for so long as its motion continues in its normal direction, it tends to augment the current which flows through it with any given setting of the switch, and thus very much increases the effort to stop itself; and the higher the velocity at which the armature is travelling, the greater this effort. In fact, it would be practically impossible with a properly constructed railroad motor to prevent its reversing when the switch is thrown over far enough. This is another point in which an electric motor has a great advantage over a steam engine.

So it would seem that electricity has practical advantages over steam for this character of traffic, and there are considerations other than purely engineering ones. The use of electricity instead of steam would do much towards making a road of this character popular. We would have express and way trains, starting and stopping smoothly and quickly, moving at a high rate of speed and running at short intervals. Dust, smoke, cinders, oil and drippings would disappear; the air would be purer and cleaner. The trains would be safer and under more perfect control; motive power would cost less; depreciation on the track structure would be much less; the carrying capacity would be increased; cars would be brilliantly lighted, comfortably heated; in short, everything which would make rapid transit safe, pleasant and effective is possible by a properly developed system of electric traction.

One of the most important sources of revenue from such a system would be the sale of power for stationary purposes. Already we are operating no less than 130 different industries by electric motors, and the receipts vary from 60 to 150dols. per h.p. The extent of the application of electricity with any such general source of supply can hardly be conceived. Its profits would be far more than enough to pay the total cost of motive power.

But we must not shut our eyes to the work which has got to be done. We must not exaggerate the advantages of electricity; we must not belittle the position of a system which has been developed by the ablest engineers for the last forty years. All their experience, all their study, all their victories, form a magnificent groundwork for us to build upon, and will render the final victory of electricity more easy and certain if we build wisely and take to heart all the lessons which their years of experience teach us. In a small fraction of the forty years which have marked the development of steam engineering, electric engines will rival in mechanical perfection, in construction, and performance the best locomotives. Even to-day, weight for weight, and duty for duty, the electric motor is already rivaling and outstripping its predecessor. For the present, and for a long time to come, it is probable that for trunk-line work and for the original source of our power in an electrical system, we will be dependent upon the steam-engine, but we all hope and expect that the future will bring us some other effective means of converting the energy of coal into electrical energy, and that by some direct method which will not require the intervention of a steam engine and dynamo. It is not too much to hope for, and already experiments have been made which foreshadow this great result. The success of this discovery would produce such a revolution in the use and distribution of power as to exceed our most sanguine expectations.

SPECIFICATION OF WIRING.*

By the term wiring, is meant the whole of the materials and work for a thoroughly perfect electric installation of incandescent lamps erected and fitted up complete, in or upon the buildings in the occupancy of Messrs. Hampton and Sons, namely, Nos. 8, 9, 10, Pall Mall East, Nos. 1 and 2, Whitcombe-street, and the building in Monmouth-court, London, S.W., with the following exceptions only, namely, no electrical or other machinery, or any apparatus for generating or storing electricity, or any converter, or work in connection therewith is included.

The whole of the buildings are to be lighted throughout. There

* Proposed electrical installation in the buildings occupied by Messrs. Hampton and Sons, Pall Mall East, Whitcombe-street, and Monmouth-court, London, S.W.

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must be no interference with the existing gas lighting without permission.

The tender must be in four separate portions, as set forth in the accompanying schedule.

The parties tendering must supply a schedule and plan describing the manner in which they propose to light each shop, show-room, office, passage, corridor, staircase, or other part of each building. The number of lights must be stated, their individual candle-power, how arranged, what fittings it is proposed to supply, and their make and design. The method of arranging the conductors, and full details of how they propose to place up the whole installation.

No existing chandeliers or gas-fittings are to be utilised.

There are to be no combination fittings.

The tender must be for a thoroughly complete and perfect installation for each building, down to the smallest details. It must include the cost of all cutting and making good again, and the contractor is to provide all necessary implements, scaffolding, and apparatus, and a sufficient number of skilled workmen and labourers for the proper, expeditious, and complete execution of the works and cleaning up and removal of waste materials. And he is to supply any workmanship, materials, and labour which, although not specially named in this specification, may be, nevertheless, incidentally necessary for the proper and expeditious completion of the work described therein. And the contractor is to make good again at his own cost any damage or destruction that may occur to the works, whether by accident or any other cause whatsoever, until the installation is completed.

The contractor is also to be responsible for any damage or injury done to the buildings or to the property belonging to Messrs. Hampton and Sons that may be occasioned by the act of any of those in his employment (any property held in trust is to be considered for this purpose as the property of Messrs. Hampton and Sons).

The business carried on in the premises is not to be interfered with in any way during the progress of the work. No work is to be commenced after 10 a.m. or carried on before 6 p.m. without permission in writing.

All materials and work are to be of the very highest character and excellence.

The contractor must keep the entire installation in thorough working order and repair, at his own expense, for a period of 12 calendar months from its completion, renewal of worn-out lamps excepted.

No extra, additional, or different work will be allowed for under any circumstances whatsoever, unless an order for the same be given and signed by Mr. Musgrave Heaphy (acting for Messrs. Hampton and Sons) specifying that it is for extra or altered work.

Should Messrs. Hampton and Sons (or their representative) desire the position of any light or lights to be altered from what had previously been arranged, either before or during the progress of the work, this is to be done without any extra charge, provided it does not necessitate any work that has been placed up being done over again.

All work and materials and the entire installation in each building are to be subjected to the approval of Mr. Heaphy (acting as aforesaid), and he is to have the power of rejecting any work or materials he is not perfectly satisfied with.

All insulation tests must be to his complete satisfaction. They must be extremely high, especially with regard to earth.

If, however, from hidden or from any other causes whatsoever, within the said period of twelve calendar months, it be found that the installation, or any part of it, in any of the buildings is not working efficiently, then it shall be in the power of Mr. Heaphy to refuse to pass such part or the whole of the aforesaid installation until it has been altered and arranged to work efficiently and to his entire satisfaction, and this notwithstanding that the materials, work, and arrangement had previously met with his sanction and approval.

The whole of the work of each tender must be finished within the time specified in schedule for each portion of the work after the order to proceed with the work has been given, under a penalty of two guineas per day, for each day after that date the installation is incomplete, unless a certificate be given by Mr. Heaphy stating that such delay arose from circumstances reasonably beyond the control of the contractor.

If, in the judgment of Mr. Heaphy, the work is improperly conducted or sufficient despatch is not used about it, Messrs. Hampton and Sons shall have the power, upon giving to or leaving at the last-known place of residence or business of the contractor six days' notice in writing to dismiss him and his workmen from the works either wholly or in part, and to appoint other persons, contractors, workmen or labourers, who shall supply either by day-work or otherwise the requisite labour, workmanship, materials, means, and appliances for the due execution and completion of the contract; and the costs and charges incurred by them, or any of them, in so doing shall be ascertained by Messrs. Hampton and Sons, and paid for or allowed to Messrs. Hampton and Sons, by the contractor; and it shall be competent for Messrs. Hampton and Sons to deduct the amount of such costs and charges out of any money due, or to become due, from them to the contractor.

Payment on account of 80 per cent. of the contract price will be paid within one week of receiving a certificate from Mr. Heaphy that the whole of the work is complete and to his satisfaction, the balance will be paid at the end of 12 calendar months; provided the installation is then in a thoroughly good and efficient condition free from any defects arising from any bad workmanship, materials, or from any other cause whatsoever.

In the event of any lawsuit or injunction being brought against Messrs. Hampton and Sons, for using any part or parts of the installation placed up by the contractor, then the contractor shall indemnify Messrs. Hampton and Sons for any loss or expense they may have been put to in the matter, that is to say, if such lawsuit or injunction arises out of alleged infringement of patents only.

The lamps to be used must be Edison-Swan of 100 volts, and 16 or 18 c.p. (nominal) each.

No lamps are to be considered as less than 16 c.p. (nominal) each, so far as the conductors are concerned.

The lamps must be arranged in simple parallel.

The lighting of the show-rooms and windows must be *brilliant*.

The lights in the various buildings are to be all single, either suspended from the ceilings or fixtures on the cornices, walls, or other portions of the buildings, as may be determined upon by Messrs. Hampton and Sons.

The position of all lights must be such as meets the approval of Messrs. Hampton and Sons.

Should Messrs. Hampton and Sons, or their representative, desire the position of any light, or lights, to be altered from what had previously been arranged, either before or during the progress of the work, this is to be done without any extra charge, provided it does not necessitate any work that has been placed up being done over again.

The arrangement of the wiring, wherever practicable, must be as follows:—

The conductors from the converters must be brought to main switch-board in the converter house (or other position that may be determined). From this switch-board main circuits are to come into the buildings and be brought to distributing switch-boards, and there split up into small branch circuits, carrying not more than five amperes. Where a main circuit cannot conveniently be brought to a distributing switch-board, then it must be divided up into sub-mains, or branches, which must be so brought to distributing switch-boards.

The number of main circuits proposed must be stated in the tender.

The wiring must be so arranged that no show-room will be dependent upon one main circuit.

All work *must be surface*, except where permission to the contrary from Mr. Heaphy is given. In the event of any work being placed between floors and ceilings, special precautions against fire, as directed by Mr. Heaphy, must be taken.

The switch-boards must be of an approved incombustible and non-conducting material (if slate be used care must be taken that it is of a non-conducting quality). The switch-boards must be furnished with a switch and cut-out for every conductor.

The distributing switch-boards must be mounted on oak or teak, and have glass cases furnished with lock and keys all to pass.

The utmost care must be taken with regard to the design and arrangement of all work in connection with them, and drawings must accompany the tenders. The tenders must also state the number it is proposed to place in their positions, and the number of circuits it is proposed to lead from each.

The wiring must be so arranged that it will be equally suitable to be utilised whether the electricity be generated on the premises or supplied from the London Electric Supply Corporation by their system of high tension primary currents and converters (the E.M.F. of the secondary current being 100 volts), or from any other source. No portion of the primary work is to be included in the tender, but the tender is to include the cables from the main switch-board to the converters, the positions for which will be pointed out on the spot.

The arrangement of the wiring must be such that lamps of the same nominal candle-power will be equally brilliant in all parts of the buildings mentioned in the schedule when the electricity is on. The whole responsibility of this must rest on the contractor.

The contractor must also produce a certificate from the London Electric Supply Corporation, stating that the installation is thoroughly suitable and efficient so far as their system is concerned. This certificate must be produced before any payment will be made to the contractor.

All conductors must be composed of copper of at least 98 per cent. conductivity.

All conductors must be composed of strands.

No conductor is to be of less size than the equivalent of No. 18 B.W.G., unless permission is given.

All conductors are to be insulated in the highest manner with very thick indiarubber of the best quality, and they are to have substantial coverings of braided hemp. Samples of the kind and quality required can be seen.

No conductor is to carry more current than 150 amperes.

No conductor is to carry more current than the proportion of 500 amperes per square inch of section in the case of the mains and principal branches; nor more than the proportion of 750 amperes per square inch of section in the case of the smaller branches or wires.

No twin wires are to be used, except in those cases where permission has first been given. They must be of special make.

The conductors in the converter-room must be bedded in the walls (well apart) or placed in fireproof casings as may be determined by Mr. Musgrave Heaphy.

The position of all conductors must be indicated by a distinguishing mark in those instances where the conductors are hidden out of sight.

There is to be no bunching at the positives together, or the negatives together, without permission.

All conductors are to be encased in substantial, hard, well-seasoned wood casing. The positives and negatives must be placed in separate grooves, and where required filled in with silicate cotton, or asbestos, or other approved putty. The width of wood between the grooves should not be less than two inches in the case of the mains, one inch in that of the principal branches, and three-quarter inch in that of the smallest branches.

The covers of the wood casing should be screwed on, and the width of the sides of the casing should be amply sufficient to allow of screws being driven in when required.

All wood casing must be treated with an approved fireproof paint or compound. Reference must be made to Mr. Heaphy as to the treatment the wood casing should receive, and the paint or compound to be used. The casing should be composed of the wood known as "American white wood."

All wood casing where required to be of such ornamental character as to meet the approval of Messrs. Hampton and Sons,

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All joints must be thoroughly well made and soldered, and must carefully insulated. Specimens showing how the joints are to be made and insulated can be seen.

Cut-outs are to be placed upon all conductors down to the very smallest. Every change of section must be protected by its own separate cut-out. Single cut-outs may be used for single lights, except where they are taken directly off a main, or main branch, in which case a cut-out must be placed on each conductor.

All cut-outs must be in incombustible boxes, and none are to be placed under floors, or otherwise hidden out of sight except in those instances in which special permission is given to the contrary.

The connections of the cut-outs should be soldered where practicable.

All cut-outs must meet the approval of Mr. Musgrave Heaphy, to whom samples must be sent before any work is commenced, and who should be consulted on the matter previous to the tenders being sent in.

All lamp-holders must be of an approved type, and as incombustible as possible.

All switches must be of the best possible make and design, and such that they will not be able to rest in any intermediate position between full on and off. Samples must accompany the tender.

All switches must be mounted on slate or other approved incombustible material, and when not on the switch-boards must have behind the slate an oak or teak backing.

In many cases, individual lights must have switches. These may be single-pole.

A sketch must accompany the tender, showing how the whole of the work is to be arranged.

A sketch, showing the make and design of each fitting it is proposed to supply, must accompany the tender.

All work in connection with these must be of a specially secure character.

All ceiling roses used must be of a specially secure character, and samples must accompany the tender.

The tender must state the character of the shades it is intended to supply. Samples must be sent.

Sufficient incandescent lamps for each portion of the whole installation, together with 50 extra ones, are to be supplied.

After the work is completed, one copy of plans, properly drawn, coloured, and framed and glazed, showing the position of the work in every portion of the buildings must be supplied by the contractor free of cost.

The position of all work, down to the smallest detail, must be such as meets the approval of Mr. Heaphy, and no work is to be commenced in any portion of the building without previous consultation with him and with his permission.

The greatest possible care must be taken that the decorations in the rooms, passages, corridors, and other portions of the buildings are not injured, and that the work, as much as possible, harmonises with them.

With regard to fire risk the whole of the work must comply with the Phœnix Fire Office Rules (thirteenth edition), and must be to the satisfaction of Mr. Musgrave Heaphy, and his approval must be obtained before any payment will be made to the contractor. It would be preferable if he were consulted before any tender was sent in.

In the event of any dispute or question arising between the contractor and Messrs. Hampton and Sons (or their representative) on any matter whatsoever connected with the work or the interpretation or meaning of any part or the whole of this specification at any time during the progress of the work or after the work has been completed, or after the before-mentioned twelve months has expired, then such question or dispute shall be referred to Mr. Musgrave Heaphy to arbitrate upon and decide, and his decision shall be accepted as final and conclusive on both parties.

A schedule of prices for any extra lights (including portable lights) or work that may be required must accompany the tender. A separate sum must also be stated with regard to the cutting away and making good again, and also for the wood casing (not fixed up).

Messrs. Hampton and Sons do not bind themselves to accept the lowest or any tender. They may accept any one or more of the four portions of the tender to the exclusion of the rest. The parties tendering must do so at their own expense.

A separate tender may be sent in, stating at what price per annum the whole installation would be kept in thorough working order, and repair after the expiration of twelve months mentioned in this specification.

CITY NOTES.

Monte Video Telephone Company.—Letters of allotment in the Monte Video Telephone Company, Limited, have been posted.

The Bernstein Company.—The Bernstein Electric Lamp Company notifies that their offices will in future be at 2, Marlborough Mansions, Victoria-street, S.W.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ended August 10, 1888, amounted to £4,944.

Eastern Telegraph Company.—The Eastern Telegraph Company, Limited, notifies the interruption of its Aden-Bombay cables. The repairing ship will be in the locality of the fault in a few days' time.

Western and Brazilian Telegraph Company. — The traffic receipts of the Western and Brazilian Company for the past week, after deducting the "fifth" of the gross receipts payable to the London Platino Brazilian Company, were £4,141.

Telephonic Apparatus.—Mr. Justice Kay has made an order for judgment for the plaintiffs in an action brought by the United Telephone Company against W. D. Berry and Sons, of Huddersfield, scientific apparatus makers, for alleged infringements of telephonic apparatus.

London-Platino Brazilian Company. — This Company notifies that the half-yearly coupons, which fall due on September 1, 1888, of its £100,000 six per cent. debentures, will be paid by Messrs. Glynn, Mills, Currie, and Co., of 67, Lombard-street, London, E.C., on and after that date; and also that coupons must be left with the bankers three clear days for examination.

NEW COMPANIES REGISTERED.

The Electrical Accumulator Association, Limited.—Registered by Parker, Garrett and Parker, St. Nicholas Rectory, Cornhill, E.C., with a capital of £10,000 in shares of £10 each. Object: To purchase and acquire, and work and use the letters patent for the United Kingdom, No. 8,379 of 1886, granted to Anthony Reckenzaum, entitled "Improvements in Secondary Batteries or Electrical Accumulators," or any interest therein; to manufacture and provide, sell, deal in, or let for hire or grant licenses for the use of any instruments, machinery or apparatus for accumulating, storage, regulating, or measuring the supply of electricity or electrical currents in force. The first subscribers are:

	Shares.
A. Reckenzaum, 7, Albert-terrace, Clapham	1
J. Stephen, 1, Cuba-street, Millwall, E.	1
W. Adams, Hithersett Lodge, Putney, S.W.	1
J. R. Anderson, Stretton House, Putney	1
R. Grant, Faruleigh, Westgate-on-Sea	1
A. Smith, 1, Cuba-street, Millwall, E.	1
G. Binswanger	1

The company is registered without articles of association.

The Lineff Electric Traction and Lighting Syndicate, Limited. Registered by Shaen, Roscoe, Massey and Co., 8, Bedford-row, W.C. Capital, £10,000, divided into 10,000 shares of £1 each. Object: To acquire, introduce, work, develop, and manage certain new inventions for operating tramways or railways by means of electricity, for which letters patent have been granted, one of which bears date June 10, 1887, and is numbered 8,380, and the other of which bears date October 4, 1887, and is numbered 13,447, and all the benefits, privileges, and advantages of, or to be derived from, the said inventions and letters patent, and to take out or acquire letters patent for the said inventions in any colony or foreign country; to light roads, thoroughfares, houses, shops, or public buildings. The first subscribers are:—

	Shares.
R. Applegarth, 11, Queen Victoria-street, E.C.	1
A. G. Lineff, 88, High-road, Chiswick	1
E. H. Bayley, 42, Newington-causeway, S.W.	1
R. G. Applegarth, 11, Queen Victoria-street, E.C.	1
A. E. Stone, 11, Queen Victoria-street, E.C.	1
E. G. Church, 120, Pollock-road, New Kent-road	1
J. S. Keay, 90, Ladbroke-grove, W.	1

There shall not be more than five Directors, and the first shall be E. H. Bayley, J. S. Reay, A. G. Lineff, and R. Applegarth. Each Director shall hold at least 250 shares in the Company. The remuneration to the Directors shall be fixed by the Company in general meeting.

Laurence, Paris, and Scott, Limited.—Registered by F. G. Monkland, 78, Gracechurch-street, E.C., with a capital of £30,000, in shares of £10 each. Object: To adopt and carry into effect an agreement dated June 24, 1888, and made between E. A. Paris and W. H. Scott of the first part, R. Laurence of the second part, and G. Cruikshank, as trustee of the Company, of the third part; to acquire and carry on the business of E. A. Paris and W. H. Scott, electrical engineers. The first subscribers are:—

	Shares.
E. A. Paris, King-street, Norwich	1
A. J. Laurence, 13, Copthall-court, E.C.	1
W. H. Scott, King-street, Norwich	1
R. Halewood, Norwich	1
T. W. G. Taylor, Norwich	1
P. E. Laurence, 13, Copthall-court, E.C.	1
L. Laurence, Clapham-park	1

The number of Directors shall not be less than three nor more than eight, and the first shall be R. Laurence, E. A. Paris, and W. H. Scott. The qualification of a Director shall be the holding in his own right of at least 100 shares in the capital of the Company. The remuneration of the first Directors shall be the sum of £250 per annum each, and 25 per cent. of all net profits after 5 per cent. per annum dividends have been paid.

PROVISIONAL PATENTS, 1888.

AUGUST 3.

11,274. **Improvements in galvanic belts or chains.** John Beveridge Thistleton, 53, Chancery-lane, London.

AUGUST 4.

11,312. **Certain improvements in scoring boards used by billiard players and others, and in means for operating the indicating devices by electricity.** Joseph Hamer, Commercial-street, Halifax.

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11,328. **Improvements in obtaining electricity for electric lighting motive power and other like purposes.** William Boggett, 34, Southampton-buildings, London, W.C.

11,338. **Improvements in telephone line circuits.** Leon Kelner, 24, Southampton-buildings, London, W.C. (Complete specification.)

AUGUST 7.

11,352. **An improved electric pen or pen and holder, specially applicable for stippling and similar purposes.** Joseph Scholefield, 2, East-parade, Leeds, Yorkshire.

11,354. **New or improved methods of and apparatus for utilising energy and the application thereof to a certain useful purpose.** James Grieve Lorrain, Norfolk House, Victoria Embankment, London, W.C.

11,376. **Improvements in syphon recorder telegraph instruments.** George Draper and William Henry Ash, 50, Old Broad-street, London, E.C.

11,377. **Improvements in syphon recorder telegraph instruments.** George Draper and William Tuck, 50, Old-street, London, E.C.

11,388. **A system of, and means or apparatus for, automatically and electrically indicating the breaking of a train, or for actuating signals on railways.** John Leman Eckersley Daniel, 68, Fleet-street, London.

11,403. **Improvements in apparatus for the propulsion of vehicles by electricity.** Henry Harris Lake, 45, Southampton-buildings, London. (Francis Joseph Weis, United States.) (Complete specification.)

11,411. **Improvements in armatures for dynamo-electric machines.** Alexander William Meston, 77, Chancery-lane, London, W.C. (Complete specification.)

AUGUST 9.

11,475. **An improved electrical stop-motion for automatically arresting the operations of apparatus for folding envelopes and similar articles of paper.** Carl Blanke, 1, St. James'-square, Manchester.

11,479. **Improvements in the manufacture of iodine and iodoform by electrolysis.** Thomas Parker and Alfred Edward Robinson, 70, Market-street, Manchester.

11,490. **Improvements in lock switches for electric circuits.** Arthur Cecil Cockburn, 2, Aubert-park, Highbury, London, N.

11,491. **Improvements in the insulation of electric conductors and for the preparation of wires to prevent vibratory sound when used for telephonic and other electrical purposes.** Donald Nicoll, 12, Buckingham-street, Charing Cross, London, W.C.

11,495. **Improvements in the arrangement and construction of telephonic exchange systems.** John James Mann and James Cutlan, Ordsall Lane Mills, Salford.

11,503. **Improvements in electric generators.** Lazarus Simon Magnus Pyke and Harry Theodore Barnett, 433, Strand, London.

11,511. **An improved system of automatic electric signalling for railways, and means or apparatus for use therewith.** John Leman Eckersley Daniel, 68, Fleet-street, London.

11,514. **Electrically controlled apparatus for checking, extinguishing, and preventing the spread of fire, and for simultaneously giving the alarm.** Thomas Ralph Douse, 166, Fleet-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

AUGUST 2, 1887.

10,611. **Improvements in electrical batteries.** Richard Philip Milburn, 46, Grainger-street West, Newcastle-upon-Tyne.

AUGUST 6, 1887.

10,833. **Improvements relating to electric lamps.** Frederick Richard Boardman, 433, Strand, London.

10,838. **Improvements in electrical switches.** Frederick Lawrence Rawson and William White, 1, Queen Victoria-street, London, E.C.

AUGUST 10, 1887.

10,952. **Improvements in or connected with dynamo-electric machines and electro-motors.** Lucien Anspach and Léon Gerard, 433, Strand, London.

AUGUST 31, 1887.

11,802. **Improvements in and relating to the manufacture of incandescent lamps, and the methods adopted for converting old lamps into new, materials used therefor and in combination therewith.** Arthur Shippey, 13 and 14, King-street, Cheapside, London.

SEPTEMBER 9, 1887.

12,203. **Improvements in dynamo-electric machines.** Thomas Lynch Hemming, Cobden Buildings, Corporation-street, Birmingham.

OCTOBER 1, 1887.

13,320. **Improvements in electric regulators.** John Grice Statter and Sidney Linton Brunton, Norfolk House, Norfolk-street, London, W.C.

OCTOBER 6, 1887.

13,558. **Improvements in or relating to casings for electrical conductors and apparatus.** Percival Everitt and Percy Ruskin Allen, 4, South-street, Finsbury, London.

13,567. **Improved automatic electrical firing mechanism for naval ordnance.** Alexander Melville Clark, 53, Chancery-lane, London. (Paul Oriolle, France.)

OCTOBER 15, 1887.

14,024. **Improvements in secondary batteries or electrical accumulators.** Nicholas de Benardos, 47, Lincoln's-inn-fields, London, W.C.

14,029. **Improvements in electrical tramways and railways.** Frederick Charles Allsop, Bexley, Kent.

APRIL 17, 1888.

5681. **Improvements in switches used for electrical purposes.** Charles Scott Snell, Culver Park, Saltash, Cornwall.

SPECIFICATIONS PUBLISHED.

1887.

12,111. **Electric fuses for mines.** W. P. Thompson. (Dumas.) 8d.

12,325. **Telephonic apparatus.** W. Fairweather. (Western Electric Co.) 8d.

12,432. **Motor Engines.** W. D. and S. Priestman. 8d.

1888.

7805. **Producing, &c., electric currents.** H. J. Allison. (Fritts.) 11d.

8223. **Magnetic separator for extracting ferruginous matter from ores, &c.** A. H. Reed. (Conkling.) 6d.

8596. **Automatic telegraphy.** J. Y. Johnson. (Mallet.) 1s. 1d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday.
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	3½
12 Feb.	2/0	— fully paid	5	4½
26 April	1%	Anglo-American	100	40⅛
26 April	2%	— Pref.	100	67½
12 Feb., 85	5/0	— Def.	100	13½
28 June	3/0	Brazilian Submarine	10	13
14 June	1/0	Con Telephone & Main	1	¾x
15 Feb.	8/0	Cuba	10	13¾
28 July	10/0	— 10% Pref.	10	18¾
28 Mar.	2/2½	Direct Spanish	9	4
28 Mar.	5/0	— 10% Pref.	10	10
28 Mar.	2/0	Direct United States	20	9⅛
12 April	2/6	Eastern	10	12⅝
12 April	3/0	— 6% Pref.	10	14½
1 Feb.	5%	— 5%, 1899	100	108½
26 April	4%	— 4% Deb. Stock	100	106½
12 July	2/6	Eastern Extension, Australasia & China	10	12⅞
1 Feb.	6%	— 6% Deb., 1891	100	103½
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	102
28 Mar.	8/3	German Union	10	9⅛
12 April	2/0	Globe Telegraph Trust	10	6⅞
12 April	3/0	— 6% Pref.	10	14
30 April	5/0	Great Northern	10	14¼
1 Mar.	5%	Gt. Northern 5% Deb., '83.	100	108
29 Feb.	10/0	India Rubber, G. P. & Tel.	10	17½
11 May	37/6	Indo-European	25	38
30 May	3/0	London Platino-Brazilian	10	6¼
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	⅜
26 April	4/0	Reuter's	8	8
		Swan United	3½	2⅜
15 Feb.	15½%	Submarine	100	150
15 Oct.	6%	Submarine Cable Trust	100	97
29 Feb.	36/0	Telegraph Construction	12	39½
3 Jan.	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
		West African	10	5¼
1 Mar.	5%	— 5% Debs.	100	95
12 July	4/0	West Coast of America	10	6¼
30 June	8%	— 8% Debs.	100	117
11 May	9/	Western and Brazilian	15	11⅜
11 May	6/10½	— Preferred	7½	7
11 May	2/1½	— Deferred	7½	5¼
1 Feb.	6%	— 6% A	100	113
1 Feb.	6%	— 6% B	100	108
		West India and Panama	10	1½
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80		— 6% 2nd Pref.	10	7⅜
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	104

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NOTES.

Moscow.—Messrs. Siemens and Halske have commenced the work of a central station, which will be situated near the centre of the town.

Cardiff.—The Cardiff Corporation last week passed a resolution to invite the British Association to hold its annual meeting at Cardiff in 1889.

Iron Telegraph Poles.—We learn that Messrs. Bayliss, Jones, and Bayliss, Victoria Works, Wolverhampton, have booked a large order for tubular telegraph poles.

Cruto Lamps.—It is stated that the French patents for these lamps have been obtained by the house of Rothschild for a new company whose factory is situated in Paris.

The Volta Prize.—This prize of 50,000f. has been awarded to M. Zenobe Gramme, for his improvements in dynamo machines. The last award was to Graham Bell for his work in telephony.

Cable News.—It is stated that the French Minister of Finance has submitted to his colleagues a project for a convention relative to the Antilles cable, which it is proposed to submit to the Chamber.

Cost of Maintenance.—The total expense of maintenance, including everything, on a recently equipped overhead electric road running twenty cars, is certified as being only 47 per cent. of the total receipts.

Telegraph Facilities.—The Post Office authorities are erecting wires to give direct communication between Aberdeen and Kirkwall, while otherwise improving improving telegraphic facilities in the North.

Brussels and Paris.—In the exhibition at Brussels opportunity is given of experiencing long distance telephony. The grounds of the exhibition are now connected to Paris, and forty telephones are at the service of visitors.

Who Pays?—During a severe thunderstorm at Wabash, Ind., recently, lightning struck the electric wires and burned out more than half the lamps. The plant had just been accepted from the Heisler Electric Light Company. The damage was repaired in a few days.

An Alternative.—A lineman in New York, in complaining of the bad state of the wires, says: "The only way to find out if the wires are dead or alive seems to be to feel them. If you don't receive a shock the wire is dead; if you do receive a shock, very likely you are dead."

Wire-Covering Machines.—Messrs. Edes and Bradford, of Plymouth, Massachusetts, run their wire-covering machines by electricity. The machines used are invented by the firm, and some of them are so delicate as to cover wires of one nine-thousandth of an inch in diameter.

Innsbruck.—The gas company of Innsbruck are about to establish a central station for the supply at first of about 3,000 incandescent lamps. Water power is to be employed as the prime motor to drive the dynamo, and overhead wires will be used with Zipernowsky transformers. The work is to be carried out by Messrs. Ganz, of Buda-Pest.

Glasgow.—The ship "Marathon," named by Princess Beatrice during the Queen's visit to Glasgow, is one of the new fast-speed vessels expected to get a speed of at least 20 knots on trial. The vessel will be lighted throughout by electricity, and carries three search-lights—one on the conning tower, and two aft on the upper-deck sponsons.

Conduction through Gases.—Nahrwold concludes, from his experiments, that it is impossible to give an electrostatic charge to a mass of gas, but he has not arrived at definite conclusions as to the possibility of separate molecules becoming charged, which, he says, is quite possible, as the charge of the molecules could be dissipated before an observation could be made.

Montlucon.—A company is being formed to establish a central station for lighting this town. Besides lighting, it is intended to distribute current to actuate motors. The charge to be made for an ordinary incandescent lamp will be 60f.—about £2. 8s.—per year. It is thought that this amount is too high, and unless the terms are reduced the enterprise will not succeed.

Edison Plant Burnt.—Edison plants do not seem to be very lucky. Not long ago an Edison central station was burnt out, and great expedition was shown in restarting the station. Now it is the Edison machine shop at Schenectady, containing valuable machinery and apparatus, which were destroyed by fire at the end of last month, with a loss of 32,000dols.

Eastbourne.—The Eastbourne Electric Light Company state they have incurred a serious loss in the contract with the Eastbourne Corporation by supplying 16 lamps on the Grand and Marine Parades, at £25 each per year. They offer to continue the arrangement at £35 each lamp, making a total of £560 yearly under agreement for five years. The Corporation at Hastings pay £30 per annum each lamp.

Railway Work.—It is suggested that it would in some way assist the railway officials, and perhaps the general public, to have an automatic electric annunciator to indicate the time of the departure of trains. We would suggest that for the benefit of the general public it would be far better that each platform be provided with an indicator showing the destination of the next train and the time of its departure.

Leamington.—It will be seen from the report given in another column that the tension which has existed between between the electric light company and the corporation is in a fair way of being satisfactorily settled by mutual concession. The motion to give notice to stop the electric lighting has been by consent withdrawn, and no doubt, if the company and the corporation act together, the whole matter can be soon put upon a satisfactory footing.

Whittingham Asylum.—The whole of the lightning conductor system at the Whittingham County Asylum, Preston, is being extended, and new earth plates inserted to insure a more perfect termination; also twenty new conductors are being erected for the further protection of this expensive establishment. The registered system of Mr. Joseph Blackburn, of Nottingham, has been adopted, and the work is now being carried out by that firm.

The Telautegraph.—The American papers received this week contain illustrated details of Prof. Elisha Gray's new instrument, but the apparatus is not likely to be of any commercial value in this country. The efforts of the Post-Office officials are directed towards rapidity, and the introduction of a writing apparatus of this kind would tend to delay. In private matters and on private lines it possesses few, if any, advantages over the A B C instrument.

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Advance Australia.—A Melbourne syndicate has arranged with Messrs. Ganz and Co. to employ, in Australia, the Zipernowsky-Déri-Blathy system. It is stated that a central station is to be erected in Melbourne, where it is expected ultimately the power used will be something like 5,000 h.p. Another is to be installed at Assendon, near Melbourne, where about 500 h.p. will be employed. A third is proposed at Huntershill, near Sydney, which will be about the same size as that at Assendon.

Great Northern Railway.—Messrs. Hammond and Co. have, we understand, received an extensive order from the Great Northern Railway Company to light their new wagon repairing shops and offices at Doncaster. The plant to be supplied consists of three horizontal steam-engines and three dynamos. The lighting will be effected by means of 70 arc and 200 incandescent lamps. Storage batteries will be provided to supply the incandescent light to the offices, as the machinery will not be constantly running.

The Magnetic Field.—We commence in this issue a series of articles which, we do not hesitate to say, will be the most complete and instructive of any that have ever been issued on this subject. In his introductory chapter, Prof. S. Thompson says: "The most important point in theory is the theory of the magnetic field." So far as we are acquainted, the theory of the magnetic field has never been exhaustively treated, and the author of the articles to which we refer proposes to give it this exhaustive treatment.

Chelsea.—At the meeting of the Chelsea Vestry a letter was read from the Chelsea Electricity Supply Company, to the effect that the whole of the capital required for the purpose of supplying the district with electricity, namely, £32,000, had been provided, and that the company would begin the undertaking without delay. The surveyor (Mr. Strachan) said that the company proposed to lay their mains in the streets of the district under Schedule A of the provisional order. It appeared that they had found the money, and were anxious to get on with the work. He had examined the plans, and was prepared to recommend the Vestry to agree to the application. This was agreed to.

Litigation.—Our American namesake, referring to the legal decisions on the Gaulard-Gibbs and the Edison-Swan patents, says: "A careful examination of these cases has but served to confirm our first impression—that the adverse result in both was due to precisely the same cause, viz.: the utter failure of the solicitors (or patent agents) who prepared the specifications to comprehend wherein the real invention consisted, and so to differentiate it properly from the prior work of others. Each ignorantly sought to claim the whole art, instead of the particular step in advance which had really been made, and in thus grasping at a shadow the substance has been permitted to fall to the ground."

Good for Electric Bells.—It is stated that on Wednesday morning last week, at an early hour, an unsuccessful attempt was made by burglars to enter the private residence, Victoria-park-road, of Mr. John Lobb. All the inmates were aroused by the continuous ringing of an electric bell, which the burglars had unwittingly set going. Four policemen were in a few moments on the spot, and although careful search was made for upwards of an hour, the burglars got safely away. As we have often said, it is easy to guard a house electrically, so that no window or door can possibly be opened without warning. It would even be possible to guard against the cutting out of a panel of a door or a large pane of glass from a window.

Technical College Fittings.—Messrs. J. M. Adam and Co., 40, St. Enoch-square, the engineering bureau, Glasgow, have secured the contract for the complete equipment of the new workshop of Allen Glen's Institution from the governors of the Glasgow and West of Scotland Technical College. This will comprise the engine for electric lighting, ventilating, &c., for the whole school buildings, which are being constructed to the designs of Messrs. J. Salmon and Son, I.A.; also the workshop shafting, machine tools, and smithy appliances, and the stock of edge tools, instruments, and general stores for the use of the students. This firm is also engaged fitting up an extensive bleaching and finishing works plant in the Dalmarnock district of Glasgow.

Alternate Currents and Electrolytes.—Two different methods are in use for determing the electrical resistance of liquids, the one by means of constant currents, the other by means of alternating currents. Sheldon, in order to compare the two methods, made a series of measurements by both methods of the resistances of dilute solutions of potassium chloride, sodium chloride, potassium sulphate, and magnesium sulphate, of nine different degrees of concentration. In every case, the results obtained by the two methods were closely concordant, and the author concludes that both the methods, if properly carried out, are capable of giving equally good results, but he decides, according to the *Chemical Society's Journal*, in favour of the alternating current method, on the ground of simplicity and convenience.

Personal.—"On August 15, at the British Consulate, Cadiz, Herbert Laws, younger son of F. C. Webb, Esq., C.E., to Florentine Marie Antoinette (Flora), younger daughter of Joseph Bensusan, Esq., of Cadiz and New York." Such was the announcement in the *Telegraph* of August 16, and many of us who have the pleasure of knowing Mr. Webb hastened to wish him all happiness. Mr. Herbert Webb served the Indiarubber, Gutta-Percha and Telegraph Works Company in the Mediterranean and on the West Coast of South America, where he remained a year in Peru. He was with the Telegraph Construction Company in an expedition in the Red Sea, and has since been four years in the service of the Spanish National Telegraph Company, serving at each island of the Canaries group and at Cadiz, where he has, besides his ordinary duties, placed several installations of telephone, and also at Zerez.

The Liverpool Supply Company.—The new premises of this company, which have been in course of construction in Harrington-street, are practically complete. The machinery, says *Industries*, is duplicated throughout, and is all fixed in position. As soon as all the connections are completed to their existing stations, and to the new system of underground wires, the plant will be placed on duty, and run night and day. An interesting lawsuit, in which this company were the defendants, was decided in the Chancery Court last week. The owner of a hotel near the Tithebarn-street supply station claimed heavy damages for losses incurred by the vibration of the machinery. After scientific and other evidence had been given, the Vice-Chancellor visited the works and the hotel personally, and, after complimenting the company upon the excellence of their machinery and arrangements, gave them a verdict with costs, and refused to stay execution for the latter.

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New Book.—We have received the third edition of "Dynamo Electric Machinery," by Prof. Sylvanus Thompson. This edition differs from those which have gone before, and all we have to do at present is to record the publication of this edition, for it has been impossible in the time which has elapsed since the receipt of the book to examine into the changes; but it is easily seen that the first sentence of the preface is correct, and that "most of this treatise has been re-written for this edition, and much new matter has been added. In order to render the work more complete, some historical notes and a brief account of the system of electric units have been added to the introductory chapter. In that part of the book which is descriptive, the machines for furnishing continuous currents have been considered separate from those for furnishing alternate currents. The mathematical parts of the work have been entirely rewritten and curtailed." The work is published by Messrs. E. and F. N. Spon.

Edison and Swan v. Shippey Bros.—We learn that Mr. Arthur Shippey has paid the taxed costs of the Chancery proceedings incurred in this case, and therefore, according to law, the cross action brought by Shippey Bros. against the Edison and Swan Company for intimidation of their customers for using the Shippey lamps, upon which action at the trial, it may be remembered, Mr. Justice Mathews directed a nonsuit pending the appeal, is in its original position, and a fresh suit might be entered upon, taking into account the recent decision of Mr. Justice Kay, and the recent awards granted in favour of the Zanni-Shippey patents on the Continent. It is not unlikely that the Shippey system will be upheld by the owners, who claim the right to manufacture and supply all high candle-power vacuum lamps of 100 c.p. and upwards as specified in the patents; also for the low-resistance composite semi-metallic filaments of the improved King and Harrison types, suitable for battery lighting. The validity of the Shippey patents has not been tried by the English courts.

Gas and Electricity.—The effect of the electric light upon the gas companies is put thus by a New York stockbroker: "The effect has been to increase the use of gas. This is remarkable; but, nevertheless, the facts prove it to be the case. This, and natural growth of the population, has required nearly all the gas companies to increase their plants. The New York Consolidated has, within the last three months, issued for such improvements 700,000dols. 5 per cent. debt certificates (these have been disposed of by the company at over 5 per cent. premium). The Equitable, within six months, have increased their capital 1,000,000dols., selling such increased capital stock to stockholders at par, to pay for extensions and improvements. All the Brooklyn companies are either building additional holders or adding to their works. The present low price of gas stocks has largely resulted from hostile legislation; but the manufacturing has been so improved that the prospects look brighter for the stockholders in the future. In my opinion, gas stocks, which at to-day's prices are selling near the lowest prices they ever sold at, are the cheapest investments offered in the market—for instance, the Consolidated Gas Company alone owns real estate in New York City which would realise fully 50 per cent. present market quotations of the stock."

Cincinnati.—Incandescent lamps, says the *Western Electrician*, form an essential part of the decorations at the Cincinnati Centennial Exposition. In the floral hall the waterfall makes a fine display. There are twelve bridges from which project twenty-eight lights. In the basin of the fountain are lamps with coloured globes placed above reflectors. The effect is brilliant, although Cincinnati water is not the best medium for the passage of light; six vases filled with flowers and lighted by lamps form another attractive feature. Suspended above the floor is a flower-pot lighted by an incandescent lamp. The flowers are continually sprayed by a tiny fountain. The water is kept flowing by means of a small motor. Arranged among the flowers about the hall are concealed lights, which add a brilliant effect to the display. Surrounding the fountain in the park building are nine arches, each bearing thirty-six lamps with different coloured globes. On the ring above the fountain, where the arches are joined, are six 32-c.p. lamps with cut-glass globes. There are several "umbrella" fixtures with lamps in different parts of the hall. A rotary table bearing plants, among which lights are concealed, is another brilliant decorative feature. William J. Hammer, the electrical expert in charge of the Edison lights, is preparing a novel exhibit. It is a mammoth Edison electrical globe, composed of 15,000 of the regular electrical globes. This exhibit will be nearly 30ft. high. It will glow as one colossal lamp of 100,000 c.p. It stands on a base of about 3,200 globes, that will gleam pure white, except where the word "Edison" will flash and glow in coloured effects. There is the immense socket, 3ft. high, upholding the great globe inclosing the myriad smaller ones. From this great globe, which resembles a balloon, will come a soft radiance of coloured lights. At the front just over the base, in tablet form, is a shield which will gleam in red, white, and blue stripes, and the stars in blue field. On this shield will be the inscription in infinitesimally small globes of lettering, "Exhibit of Edison Lamp Company, Harrison, N. J.," employing nearly 15,000 Edison lamps, and illustrating the capacity for manufacture of the factory per twenty-four hours.

Reduction of Ores.—The Utah Mining and Reduction Company, says the *Scientific American*, whose works are situated at Bingham, ten miles south of Salt Lake City, are using the new "Meech process" in the reduction of their low grade and rebellious ores with success. The ore is passed through a crusher and rolls, crushed to forty mesh fine, thence into a disintegrating machine, four tons at a time, through a valve, with sufficient water and chemicals to treat the sulphur and refractory elements. Steam is then admitted to a pressure of one hundred pounds per square inch, and, at the same time, the mullers are revolved at about thirty revolutions per minute, generating electricity in such volume as to greatly assist in the decomposition of the ore. This is continued for three hours. The ore is reduced to an impalpable powder, many times finer than is possible by other methods, and is thoroughly decomposed and desulphurised. The water absorbs the chemicals, every atom of gold is made bright, and in condition for amalgamation. The pulp is now discharged into the amalgamator below, a revolving machine 7ft. long and 5ft. in diameter, in which are copper plates placed lengthwise, and, by hydrostatic pressure, quicksilver is thoroughly pressed through the ore by a "settler" of peculiar shape, having an electric copper wire broom to assist in gathering the fine amalgam before the tailings are discharged. The cost of the treatment is from two to three dollars per ton, and, as the gold ores treated run from 12 to 20dols. per ton, it leaves a handsome margin

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for the owners. The ore veins are large, and thousands of tons, or enough to supply the mill for the next one hundred years, are already in sight. By this process about 90 per cent. of the gold is saved. The works occupy about nine acres of land on the banks of the Jordan River, and consist of two main buildings, 32 by 64 and 24 by 34, one two-storey boarding-house, one blacksmith shop, two 35 h.p. engines, one crusher, one roll, and other necessary appurtenances are connected with the mines by the Denver and Rio Grande and Western Railway, and demonstrate in a practical manner the immense sums that can be realised from the treatment of low grade and refractory ore dumps that have heretofore been considered absolutely worthless.

Dynamos in Telegraphy.—It is stated that the Western Union Telegraph Company are replacing batteries by dynamos for working their telegraph lines. Ten thousand cells of the Callaud or gravity battery have been displaced by the dynamos, and when account is taken of the twenty thousand wire connections of the battery, the difference of cost in favour of the dynamos in the consumption of zinc and coal, the labour and attention required, the unsteadiness of the battery currents as compared with those of the machines, the accidental openings of the batteries by reason of broken wires and defective zincs, it will be seen that the change is sure to prove a very satisfactory one to the company. The new system was devised entirely by Mr. Frank W. Jones, assistant general manager and electrician of the company, and the reports from all quarters are unanimous as to the perfect manner in which it has operated from the very moment it was set in operation on July 16. The machines, which are all of the familiar Edison type, but specially wound, are located in a commodious basement at No. 187, Broadway. Each group of eight dynamos is arranged in a substantial A-shaped frame of yellow pine, the shafts running on top of the frame, a distance of 13ft. from the base. The length of the frame is 13ft.; width, 6ft.; size of timbers, 6in. by 8in., morticed and held by bolts and nuts, so that the structure may be readily taken apart and removed at any time. All being self-contained, no jar or noise is perceptible, and a person near by is hardly aware of any motion. Two 10 h.p. New York Safety Power Company's engines are so connected up that either one is placed in action instantly by a Hill clutch to operate either one group or both at a moment's notice; a power belt connects both shafts from fixed pulleys, and is arranged to be shifted to a loose pulley. One 6 h.p. engine of the same type as the above is in position alongside of the telegraph plant, and is connected up directly to a 40-light dynamo, which supplies incandescent lamps for lighting up the large and admirably arranged operating room on the fifth floor of Nos. 5 and 7, Dey-street, directly in the rear of No. 187, Broadway, and also the office of Mr. Geo. F. Lewis, the cashier of the company, at No. 187, Broadway. An electric signal and speaking tube connects the dynamo room with the operating department, so that there is intimate communication at all times between them.

Transmission of Power.—Mr. Geo. W. Mansfield, in a paper read before the American Institute of Mining Engineers, gave some points upon the practical advantages of electricity as a motive power which will prove of interest. The following table gives Mr. Mansfield's estimate of the cost of a complete electric plant for the transmission of power to various distances, the potential at the central station being assumed to be 560 volts, with loss on line 10 per cent., copper conductors being used throughout the circuit:—

H.P.	1 mile. Dols.	5 miles. Dols.	10 miles. Dols.	25 miles. Dols.	100 miles. Dols.
1 ...	450	1,750	4,250	20,250	230,250
10 ...	2,150	7,850	24,000	136,750	2,041,750
25 ...	5,050	17,950	56,850	326,850	5,044,350
50 ...	10,000	35,050	111,750	646,250	10,058,750
100 ...	19,750	68,800	221,000	1,281,250	20,072,500
500 ...	72,800	314,100	1,066,500	6,327,500	40,122,500

The potential on which this table is calculated is very low for the transmission of large powers, but is generally used to-day for power circuits. The most expensive item in the plant is the copper, but this can be reduced by taking advantage of the fact that the cost of the copper conductor decreases as the square of the potential increases. Take, for instance, an extreme case—viz, 500 h.p. transmitted 100 miles. If we double our potential, making it 1,000 volts, the cost of our copper will decrease to one quarter, or 10,000,000dols. If, now, we again double, we decrease to one quarter again, or, at 2,000 volts potential, the cost of copper would be 2,500,000dols. The total cost of the electric plant at this potential is 2,622,500dols. Obviously there is a limit to the increase of potential; and in the transmission of such enormous powers that limit may be placed at one more doubling, or 4,000 volts. This is a possible voltage, for there are many electric light circuits in our large cities to-day of this potential, and even higher. For mining operations the use of this power will often enable work to be conducted where a steam plant for various reasons could not be operated. The dynamo can be located miles away from the mine, if necessary, on some stream furnishing sufficient power to run it. Electric motors at the mine would then do all the hoisting, pumping, and drilling, and supply the power for crushers and concentrators, and do all the hauling under and above ground. To show that this is not a mere assertion it will be well, Mr. Mansfield says, to mention what has been accomplished in this direction. There are in the aggregate, in the United States, about 125 miles of railways so operated to-day; the motors propelling loads of 10 tons, at speeds of one to 15 miles per hour, to distances of eight miles, and over grades of 10 per cent. Probably 2,000,000 passengers are now annually carried on these roads. As to size, three years ago experiments were made on the Elevated Railroad of New York City, the weight of the motor used being nine and a half tons, and capacity about 100 h.p. With this motor the four regular coaches, nearly full of passengers, were drawn over a distance of two miles, and up grades of 2 per cent., at an average speed of eight miles per hour. A plant, complete, with 30 h.p. dynamo, 20 h.p. motor, wires, insulators, &c., would cost about 3,200dols., and would do 20 h.p. actual work at a distance of a mile from the station.

Indiarubber.—Mr. Warry, of the British consular service in China, who is at present stationed as political officer at Bhama, has, says the *Times*, made a report to the Chief Commissioner on the indiarubber trade of the Mogoung district. Rubber was first exported from Upper Burmah in 1870, and until 1873 the trade was free to all. Since the latter year, however, the forests have been worked under the monopoly system, five Chinese firms being the joint *concessionaires*, two supplying the money and three superintending the work. The price ranged from Rs.60,000 to Rs.90,000 per annum, but in the present year the sale of the right produced a lakh of rupees. The

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forests occupy an extensive Kachin district north of Mogoung, and stretching east across the Chinese border. The Kachins are exceedingly jealous of interference with their trees, and although at first they made the mistake of overbleeding them, they are more careful now, and though the trees seen by Mr. Warry were covered with innumerable small incisions, even up to the tiny topmost branches, they were obviously not drained to the extent of half their power. Mogoung is the headquarters of the trade; four-fifths of the yearly supply is brought in there by Kachins in the employ of Chinese, the remaining fifth is purchased in the districts by Chinese agents of the lessees. The practice is for the Chinese manager in Mogoung to make liberal advances to the Kachins to defray expenses during the collecting season; when the rubber is brought in the refund is made by selling the rubber to the manager at half the market price. Formerly the Kachins were cheated in the weighing, and they retaliated by passing off indiarubber balls, the insides of which were mostly stones and dirt. The travelling Chinese agents who also collect rubber merely travel from place to place, buying such quantities as the Kachins offer, but as the latter have no standard weights they are usually cheated to the extent of about 70 per cent. The profit on this difference of weight more than pays the expenses of the agents. In most cases rubber is the subject of certain transit charges through the Kachin districts, the tsawbwas, or local chieftains, levying a certain toll—perhaps two or three balls out of a hundred. So long as these charges do not amount to 10 per cent. there is no complaint; they sometimes exceed this, and then the Chinese protest, usually with success. An ex-chief of Mogoung, who is now a fugitive, was of great service in arranging disputes of this nature, and now a regular expenditure in presents to the chiefs is necessary in order to keep the amount of the transit dues at a reasonable level. Whatever the toll, the Chinese manager and Kachin owner bear the loss in equal shares; but the latter is amply compensated by being housed and fed at the expense of the Chinese during his stay in Mogoung. Last year a new district was opened, and a Chinese capitalist employed 400 Chinese and Shan labourers to work the forests in the neighbourhood of the amber mines. The local Kachins objected to the inroad, and insisted on their right to the forests. A compromise was reached, 200 of the labourers being sent back at once, the remainder collecting rubber under Kachin supervision, to whom 10 per cent. was to be paid, and 200 Kachins, paid at the current rate, took the places of the 200 dismissed coolies.

Electro-Motor Possibilities.—A subsidiary paragraph in the prospectus of almost every new electric company says something about distribution of power. It is, perhaps, too early in the day to hint at the possibility, that, in all probability, the subsidiary idea will ere long take first place, and that the distribution of power will bring more grist to the mill than the distribution of light. Few outside those actually engaged in business have the faintest idea as to the possibilities of the distribution of power. Only let our companies get over the primary difficulty of getting underneath the streets or above our heads with their mains, and they will find plenty of work to be done in supplying current for motors. This is what our American contemporary, the *Electrical Review*, says upon the subject, and with certain reservations, we endorse all that it says, and we are not sure but that a central station instituted primarily for the distribution of power—say, in Tudor-street—would be able to supply, within a very short period, from one to two thousand horse-power. "Just what part the electro-motor is to take in the future is a theme of engaging interest. Those who have not the time, perhaps not the inclination, to study it will very naturally content themselves with what they know or have heard of its first trials, when its apparatus was crude and complicated, its constructors inexperienced, its accomplishment at best but of trifling value. When a man sets out to explore the air and only succeeds in reaching a high altitude, his venture is set down as a failure—though, in reality, the first great step toward the accomplishment of his purpose has been gained. Only the student or the thinking man will look ahead at the splendid possibilities that he has opened the way to. No one now doubts the potency, the practicability of the steam-engine. Notwithstanding its enormous waste of power, it will turn the shafting of a great mill, propel a 10,000-ton steamer at great speed, or haul thousands of tons of dead weight along the rails. Once, however, it was a crude mechanism, its every promise laughed at even by thinking men. It required a half-century of experiment to bring it to its present state of perfection The electro-motor, on the other hand, has been under experimentation scarcely a decade, and, thanks to the indomitable perseverance and intelligence of its projectors, has made great strides on the road to perfection—indeed, many times greater than the steam-engine; and if there be any who doubt its power to supersede the steam-engine in at least an important portion of its present field, they have only to study the theory on which it is constructed, its economy, and the advantages offered by electricity as a motor, to be convinced. Mr. Frank Sprague, who has had large experience in electro-motor construction, says that, so far as trunk-lines are concerned, it is not likely for many a day to take the place of the locomotive, but agrees with other eminent authorities that it will usurp the place of the steam-engine, and in the not distant future, too, in that vast field where small quantities of power must be distributed over a wide section. In the city of New York there are thousands of small factories, mills, passenger elevators, and innumerable other demands for a constant supply of power. However small the power required, there must be an engineer and constant shoveling of coal, with its accompanying evils of ashes and dust. Think what a saving there would be in wages, in machinery, in fuel, and in the handling of fuel and its residuents, if only the power required in a single district could be generated at and distributed from a single point! One 1,200 h.p. engine would drive the shafting in over a hundred small shops, run many elevators, and the like. Instead of the 150 and more engineers and stokers, two engineers, with a few helpers, would suffice. With steam this is not possible, but with electricity it is not only possible, but practicable; indeed, it has already been accomplished in a small way, and the great scheme itself only waits upon the working out of more economical processes in the transmission of electrical energy to a distance. So rapid has been the development of electrical apparatus, that at times it seems as if one improvement had scarce time to appear in full view ere another was treading upon its heels. This being the case, the impropriety of establishing a great plant for transmitting small parcels of power before the best known method of transmission is hit upon, is immediately obvious.

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THE MAGNETIC FIELD.—I.

The conception that a magnetic field contains, or, to speak more correctly, is composed of, lines of force has been so fruitful of practical results, that we have now come to look upon lines of force as an almost indispensable part of our collection of intellectual tools to be used in the solution of electro-dynamic problems. There is, however, a danger that the very simplicity of their conception may lead us to misunderstand or misapply lines of force. We are apt to make too much of mechanical analogies, and in our endeavour to represent every phenomenon by some such analogy there is a danger that we may apply mechanical and concrete notions to purely mathematical conceptions, or, so to say, ideal conceptions, which cannot properly be so represented. To the trained mathematician there is no such danger. He is used to deal with abstract ideas, and is able to always keep before his mind the boundary-line between abstract reasoning and concrete representation; but as by far the larger number of those engaged in electrical engineering are not trained mathematicians, a few articles on the subject may be useful. We propose, in the present series, first to point out some of the instances where a too concrete and mechanical conception of lines of force fails, and then, after having defined what limitations are necessary to avoid the error above alluded to, we shall endeavour to establish a practical working theory of lines of force, and show its application to some of the more important problems connected with dynamo-electric engineering. In treating such a subject it is obviously impossible to dispense entirely with mathematics, but we shall limit the mathematical treatment to what is unavoidable, and present the formulæ in the simplest possible shape.

The obvious, and, so to speak, most mechanical, way of conceiving a magnetic field is to imagine the space in which the field exists to be traversed by a definite number of lines of force, which by their density—that is, the number contained in unit area of cross-section—and their direction in space determine the magnetic properties of the field. Let us take the simplest case of a uniform field, where the density is constant over each square centimetre of cross-section, and where all the lines are parallel. Such a field might mechanically be represented by a number of threads stretched across the space between fixed points. Each thread has the property of exerting unit force in its own direction upon a unit magetic pole placed on it. Now, as the number of threads is finite, it is obviously impossible that a thread can pass through every point in the field, and, therefore, if we place the pole between two threads it would, according to our mechanical representation, not be acted upon at all. Experiment, however, shows that in whatever part of the field we place the pole, it experiences the same force and in the same direction. The lines can therefore not be absolutely fixed in space, but must have a certain power of shifting laterally to pick up poles which happen to have been placed by their side. In this case, which line shifts? That which happens to be nearest, one would naturally suppose. But how, if there be two or three lines equally near; do they all shift and lay hold of the pole placed within their reach? Obviously not, for in that case this pole would experience the joint efforts of several lines, and tend to move with a greater force than if properly placed on only one line. Here it will be seen that our mechanical analogy already breaks down. We cannot represent a magnetic field by lines like the trees in a forest, or the stalks of straw in a cornfield. If we imagine two magnetic fields so placed to each other that the lines separately considered would cross each other, we shall also see that the mechanical representation becomes useless. Imagine the exploring pole placed exactly into the intersecting point of two lines. It would then have a choice of directions, and might travel along one or the other of these two lines with equal facility. But we know from experiment that in each point of the field there is one direction, and one only, along which a free pole is urged. The crossing lines must therefore in some manner be merged into one compound line at their crossing point. But how about their separating again beyond the crossing point? The whole thing is inconceivable. We must try and find another method of representing lines of force mechanically. Such a method is easily found. Imagine the rigid lines replaced by a kind of magnetic wind or stream of some kind of matter capable of exerting force by friction or impact upon magnetic bodies, the force to be determined by the extent of surface of the body in our mechanical model, which surface we suppose to be a measure of the amount of free magnetism emanating from a magnet pole when placed in a real as distinguished from a model magnetic field. The field would in that case be represented by stream lines, its strength by the velocity of flow, and its direction by the direction of flow.

Now let us see whether the substitution of a dynamical for a static analogy has removed the difficulties of mechanically representing the magnetic field to which we have drawn attention above. First, with regard to a uniform field. This we now represent by a stream of liquid or gaseous matter having inertia, and all the particles moving in the same direction, and with the same velocity, say, a steady uniform wind. Into whatever position within the moving column we place a body, say, a sphere, to represent unit pole, we shall find it acted upon by the same force, and thus far our analogy is not open to the same objection as pointed out above for a field composed of rigid lines or threads. The case of two fields crossing each other can also be represented without difficulty by two currents flowing across each other, for they will blend and combine into one current, within which the stream lines have in each point a perfectly definite direction. In so far as the geometry of our mechanical model of a magnetic field is concerned, the analogy is perfectly correct, but as regards its dynamics we must make a reservation. It is well known that the force exerted by impact or friction of a liquid or gaseous stream upon a solid varies as the square of the relative velocity, certain minor disturbing influences neglected. But to make our analogy fit, not geometrically, but also dynamically, we must assume that the force varies directly as the absolute velocity of flow, and is independent of the relative velocity. This can be shown in the following way. Imagine the field emanating from the end of a long straight bar magnet. This can very nearly be represented in the old method by a definite number of straight lines, all radiating evenly from the pole of the magnet; and in our new way by the movement of the particles of a gas generated in the pole. To fix ideas, let us assume that by some means we arrange to have a continuous supply of gunpowder to the point which represents the pole, and that this powder is there ignited. The products of combustion from what may be termed a continuous explosion will disperse in all directions, producing a wind the straight stream-lines of which are directed away from the pole. Now, the velocity of flow must be less the further away from the pole we test it; and, neglecting disturbing influences, we shall find that the velocity, although equal at equal distances all round the pole, varies inversely with the square of the distance; and according to the ordinary laws of dynamics the force exerted upon a body placed in the way of this flow would vary inversely with the fourth power of the distance. This would, however, not correctly represent the law of magnetic attraction or repulsion. We know that the force varies inversely as the square of the distance, and to make our analogy perfect we must therefore asume that the force of impact or friction varies directly as the absolute velocity in every point, and is independent of the relative velocity between the fluid and solid body; so that when the latter begins to move the force is not diminished.

There is yet another reservation necessary to make our mechanical model a correct representation of the magnetic field. We have said that the particles of matter composing the magnetic wind or current must have inertia. This is indeed necessary in order that a mechanical force may be exerted upon the body brought within the influence of the current, for whether we regard this force as due to impact or friction, it could not exist if the moving fluid were devoid of weight. Yet if we admit this substance which flows with a certain velocity to have weight, we must allow it to be subjected to all the dynamical laws appertaining to ponderable bodies, such, for instance, as the law of centri-

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fugal force. On the other hand, we know that lines of force are not subject to the influence of centrifugal force, or, at least, if such influence exists it must be counteracted by some other force, for the lines will, in magnetic metals at any rate, turn sharp corners with the same facility as they flow along a straight path. If centrifugal force existed, and were not counteracted by some other force, the lines, where they curve, would show a tendency to bulge out farther and farther, which is contrary to experience. Lines of force always show the opposite tendency—namely, to shorten themselves. We must, therefore, assume that the fluid the movement of which constitutes the magnetic current is either not acted upon by centrifugal force, or, if so acted upon, is at the same time subjected to some other force which prevents the flying outwards of the particles when moving in a curved path. Such a force might be one of attraction between particles succeeding each other in one and the same stream line, and by this assumption might also be explained the well-known tendency of lines of force to shorten themselves. Whether we accept the one or the other of these theories is immaterial; the result is the same—namely, non-intervention of centrifugal force. Moreover, we must assume in either case the existence of attraction between succeeding particles in a stream line, only to a different extent. If we allow centrifugal force, this attraction must be greater than it need be if we assume that this force has no existence. In the former case, this attraction must counteract not only centrifugal force, but also the repulsion which experiment shows to exist between neighbouring lines of force. In the latter case, the attraction between succeeding particles in one stream line need only be sufficient to balance the repulsive effect between one stream line and another. If we place over the poles of a horseshoe magnet a sheet of paper, and sprinkle it with iron filings, we obtain the well-known figure showing the lines of force. Those lines which are in the centre of the figure pass straight across between the two poles, whilst the lines on either side are more or less curved, the curvature increasing with the distance from the centre line, or what might be called the polar axis of the field. This peculiar configuration of the lines of force or stream lines, as the writer prefers to call them, is easily explainable on the assumption that there is a laterally repelling force between neighbouring lines. The lines near the polar axis being subjected to lateral pressure from all sides equally, remain straight. A little way further out the lateral pressure becomes unbalanced, producing a slight bulging of the lines. Further out still the want of balance of pressure on both sides of any particular line becomes still more pronounced, with a consequent increase of curvature, and thus the peculiar appearance of the lines, as revealed by the familiar experiment with the iron filings, is brought about.

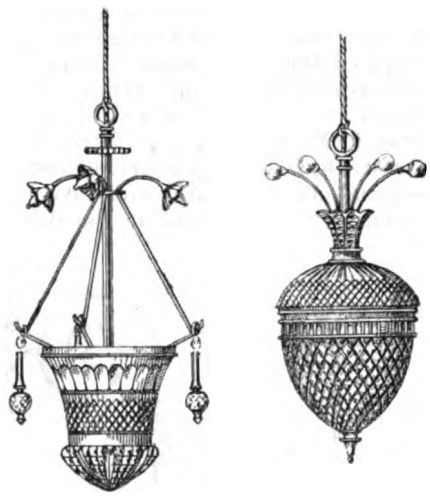
(To be continued.)

ARTISTIC FITTINGS.

IV.—F. AND C. OSLER.

In our previous articles on artistic fittings for electric light we have described and illustrated designs of fittings by professedly electrical manufacturing firms, whose business deals mostly with electrical appliances, and whose products consist of applications designed for all requisite uses as electrical fittings, and made of varying materials, brass, copper, silk, ebony, &c., combined with plain and coloured and more or less decorated glass. In our article this week we illustrate some very beautiful special designs of electric light fittings, constructed almost entirely of cut glass, made by the firm of Oslers', of Oxford-street, whose business is primarily that of cut glass manufacturers in all its branches—dining sets, chandeliers, lamps, and all manner of table fittings—but whose special department for the manufacture of cut glass electric light fittings is rapidly increasing. A large branch of business is done in this department, chiefly, of course, amongst high-class mansions and country houses, and for those who are wishing to obtain a brilliant and splendid effect, irrespective of paying the smallest amount possible for their fittings, a glance at Messrs. Oslers designs will convince them of the elegance and tastefulness of these fittings in cut glass.

Messrs. F. and C. Osler have their manufactory in Birmingham, where the various designs are prepared by a set of skilled artists and workmen, whose care and dexterity



FIGS. 1 AND 2.

may be almost said to equal that of jewellers, and who are constantly engaged in the beautiful and delicate processes of cutting the glass, and building up the various designs. The show-room of Messrs. Osler in Oxford-street is simply a palace of splendour, filled with art pottery, and long rows

FIG. 3.

of delicate wine-glasses and table services. With these, however, we have nothing to do, and notice only the special fittings adapted to electric light. Many patterns for various positions are exhibited at these rooms, a few of the best and most typical instances of which we have attempted to reproduce, but the variety is almost endless, and, generally,

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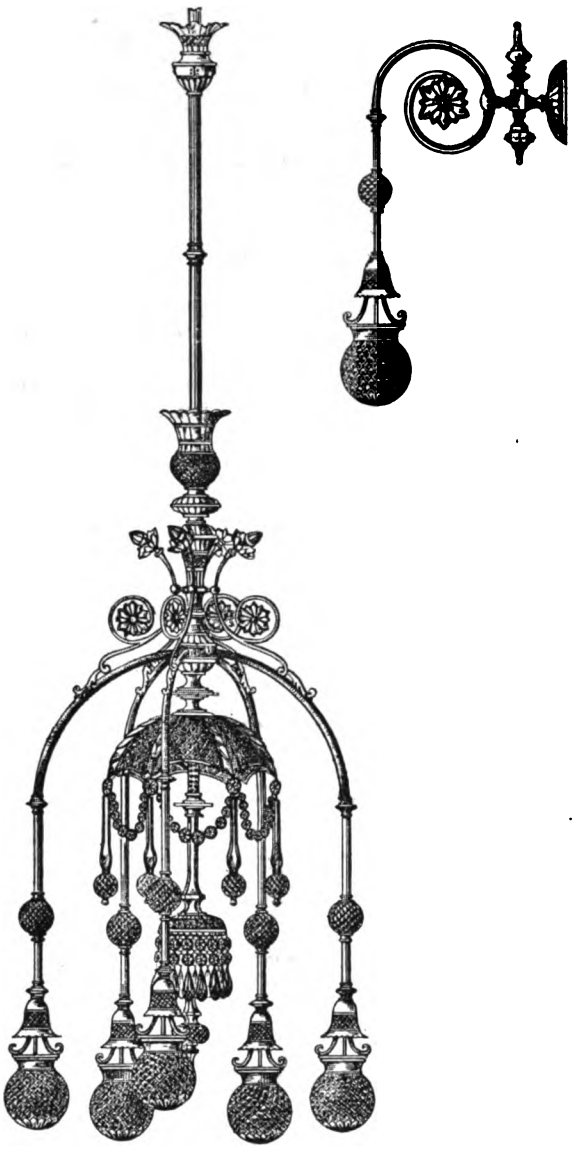
the greatest care is taken to supply special designs for each of the more important customers.

Of course it can easily be imagined that, while some of the simpler fittings in cut glass are scarcely, if any at all, more expensive than many of a similar nature in polished brass and copper, yet in many of the more elaborate and beautiful designs the cost may rise to scores, or even in some cases, hundreds of pounds for elaborate cut glass electroliers. In such cases it is not uncommon to hear that the cost of the fittings themselves exceed, or even double, the cost of the electric part of the installation. An instance has been given of a country house very handsomely and brilliantly decorated with special cut-glass fittings by Messrs. Osler, where the cost of fittings alone was over £1,000; the cost of the machinery and other apparatus would not be nearly equal to this sum. Other instances in the West End of



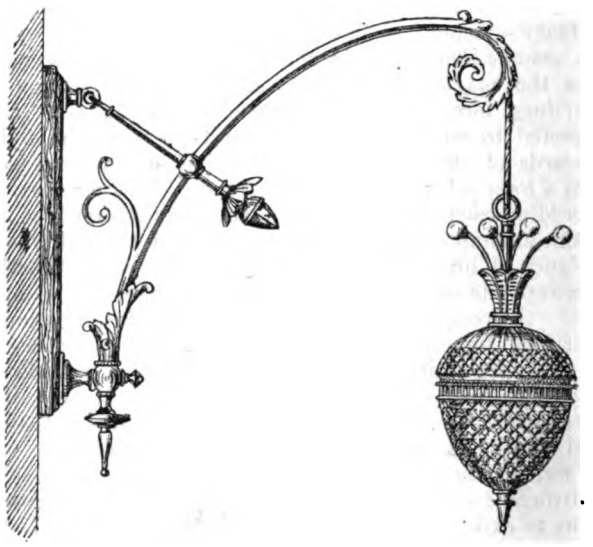
FIGS. 4 AND 5.

London, where the cost for fittings has been several hundreds of pounds, indicate that purchasers of proposed electric lighting plants are not always chary about the first cost of their fittings, provided they can obtain something equivalent for their outlay.

The effect of cut glass used in conjunction with incandescent electric lamps is exceedingly fine. It is necessary, of course, to secure the greatest effect, to keep the whole of the glass well cleaned periodically with cloths or leather; but in an establishment where constant care is given to the silver an equal attention to the fittings can be secured. When clear and transparent, the varied facets of the cut glass break up and refract the light with very beautiful effect. The glow even of the filament of an incandescent lamp is almost too concentrated to regard alone, and the blending of broken light in the clear surfaces of the cut glass is its chief charm. Besides this, there is not the loss in light with cut glass that must always attend the use of obscured or opalescent glass, and altogether a very rich and handsome effect is produced by its decorative use for this purpose.

Generally, there are two types of cut-glass fittings manufactured by this firm—namely, those in which nearly the whole design is in glass, with merely a basis of metal

FIG. 6.



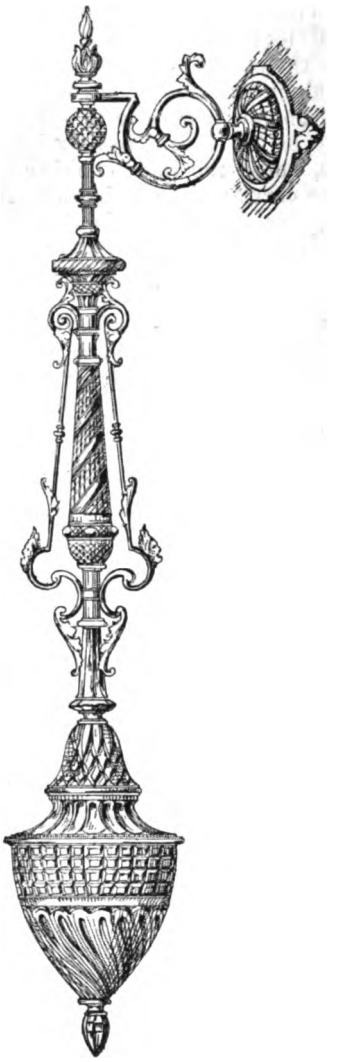


FIG. 7.

tubing upon which the design is built, and those in which the design is mainly or in great part of polished brass, with which cut-glass decorations are combined. These fittings are made in single pendants, as standards, as brackets for single, or for two or more lamps, and in large electroliers for the centre of important rooms. Messrs.

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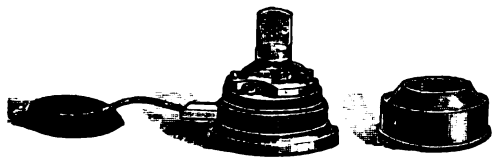
Osler also make a switch with a cut-glass cover and handle, to match the other fittings.

In our illustrations, Figs. 1 and 2, are two designs of cut glass one-light pendants. A variety of shapes of single pendants are made; these shown are, perhaps, two of the prettiest. The next illustration, Fig. 3, is of a large and handsome drawing-room electrolier for six lamps. It is made in polished brass, with cut glass globes and bowl and solid glass rods, and decorated with cut and wreathed ornaments and crystal flowerets.

The fittings for special houses are often made in various designs to match throughout. Fig. 4 shows one of these, a five-light electrolier, with pendant-shaped globes and with canopy and wreaths in cut glass, and Fig. 5 shows a bracket to match. Fig. 6 is a pretty design of suspended pine-shaped cut globe, with light wall bracket. Fig. 7 is a large and very handsome and imposing drawing-room bracket in the mansion for which they were designed, a pair of these large brackets fixed one over each end of a carved mantelpiece making a very fine decorative effect.

WOODHOUSE AND RAWSON'S SWITCHES.

Various improvements are being introduced in switches by the Woodhouse and Rawson Electric Supply Company, with the idea of obtaining special suitability for certain situations, and with the general idea of greater theoretic and practical perfection. One of these, patented by Sir David Salomons, and named by him the Broomhill Switch and Connector, has been designed for use with a portable lamp. The switch acts independently of the lamp circuit,



The Broomhill Switch and Connector.

while, by using the connector itself as a lever, the portable lamp can be switched on and off without taking out the connector.

CORRESPONDENCE.

ELECTRIC TRAMWAY WORK.

To the Editor of The Electrical Engineer.

Sir,—As none of our electrical tramway engineers have replied to your correspondent's request, perhaps the following information may assist him as to what he is desirous to find out.

For his information I may say, that about six years back, as near as I can remember, I witnessed some experiments in electrical traction at Leytonstone, carried out by Mr. Radcliffe Ward on behalf of M. Phillippart, who, I believe, introduced into England the Faure type of accumulator.

The vehicle used for these experiments was a slightly-built car, either of French or Belgian manufacture; the motor used was of the well-known Gramme type, and, as far as I can remember, the batteries of the Faure accumulator type were placed on the top of the car.

The experiments were somewhat crude, but quite sufficient to show that electrical traction had a great future before it, especially when more fully developed.

I may also say that M. Julien, of Brussels, publicly ran an electrical car during the Antwerp Exhibition, held in 1885, upon which I rode some dozens of times with considerable pleasure, as this car ran very successfully, although the batteries were charged under great difficulties from an ancient type dynamo, and a very shaky old engine, and bad belting. The whole plant was only worth about £50, which fact, I think, should be good evidence that electrical traction with modern motors and improved batteries can be made to become, in the hands of practical men, a good paying industry for capital invested.

I believe Dr. Finny, an American, ran the first electrical car by overhead conductors, either in the year 1881 or 1882, at Pittsburgh, U.S.A., his patents are now owned by the Overhead-Conductor Electric Railway Company.

Dr. Finny appears to be one of the earliest experimenters in electric traction. There are records of his work dating as far back as 1878.

I have some slight idea that Profs. Ayrton and Perry, also Dr. Woodward, experimented in traction work in 1883 or 1884. I cannot remember the exact dates, but I have no doubt the above-named gentlemen can do so if applied to by your correspondent.—Yours, &c.,

A. Shippey.

INSTITUTE OF MEDICAL ELECTRICITY.

To the Editor of The Electrical Engineer.

Sir,—With reference to the letter of Mr. Newman Laurence which appeared in your last issue, I venture to trouble you with a few remarks on the subject.

The wonderful efficacy of electro-magnetism as a means of cure in all acute and chronic diseases is fully recognised, though not so widely known by the general public as it ought to be; and if an institute of medical electricity could be established somewhere in the West End and the best apparatus only used, I am satisfied an incalculable good to suffering humanity would result—even the death rate would be materially reduced. It is well known to all who have been under treatment that the electric current drives out of the system through the pores or other channels all deleterious matter, and is useful in almost every disease, reaching to parts not even known to be affected, without, however, lowering the system like drugs or the Turkish bath. The treatment is not only powerfully tonic, but also gently and naturally stimulating, and it almost always induces refreshing sleep, which those who are afflicted with insomnia should note.

The current may be applied free from shocks of any kind, so that the most sensitive or nervous person can take the treatment without any risk or fear.

It is, perhaps, worthy of consideration by the promoters of the institute whether it would not be advisable to incorporate it in, or amalgamate with, the Electro-Therapeutical Society, established some years ago in Eastbourne-terrace, of which Edward Herford, Esq., J.P., coroner for Manchester, is the chairman, in order that a strong and influential directorate may be formed, and I shall be glad to hear the views of those more immediately interested on this point.—Yours, &c.,

Alpha.

August 22nd, 1888.

ELECTRIC CURE.

To the Editor of The Electrical Engineer.

Sir,—As you have most usefully opened your columns to the discussion of this great subject, I hope you will let me send you particulars of a society formed for a kindred purpose to the institute which you have recommended. The society, you observe, has the support of many good men, united solely by a sympathy for suffering humanity. I could say much of my well-known (almost perfect) cure from complete prostration by paralysis, and of cures similarly effected from varied ailments amongst my friends. You will, perhaps, permit me to mention, from my own knowledge, what seems almost a miraculous case of a gentleman suffering three or four years ago from chronic rheumatic gout, progressive paralysis, enervation, &c. He was entirely helpless—hands and fingers drawn out of shape, legs and feet powerless. His physicians said his case was utterly hopeless; but his friends applied to Mr. Grigg, by whom he was treated twice a day for nine months, and recovered perfect use of his limbs and powers. He was married soon after, and has now a son and heir.

I have no right to trouble you with other illustrations of Mr. Grigg's powerful curative agency; but I submit that we, and your readers, are entitled to have this system put at least *pari passu* with that which you have especially favoured, and as against such as you truly designate quackery, conducted for commercial purposes.—Yours, &c.,

Edward Herford,
J.P. for Lancashire and Coroner for Manchester, Chairman of the Electro-Therapeutical Society.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that* PROF. D. E. HUGHES, F.R.S.

TRACTION.

Elsewhere we give a report upon the Lineff electric traction system as applied to a short experimental line upon the West Metropolitan Tramway. The figures as given by Mr. Kapp are the result of direct experiment, and thus far more valuable than others which are deduced from theory. The introduction of electric traction seems to be the most important development of electrical work in the near future. We recently referred to a syndicate whose object is to introduce electric traction upon the Metropolitan Railway, another to exploit the series motor system, while Messrs. Crompton and Co. are carrying out experiments for the Elieson Company. The Brush Company, again, has work in hand, the Lineff Company has been registered, and the Southwark Subway will probably be worked by means of electricity. Other schemes are under discussion, and thus the report of Mr. Kapp comes at an opportune moment. If the promoters of the Southwark Subway had intended to provide a line most favourable to electrical work, they could hardly have done better than they have, and it remains to be seen how electrical engineers will use the opportunity. The result depends very much upon directing the directors, as if they will but employ a competent engineer and fight more or less shy of patentees and hobbies, they will achieve a success that will amply remunerate them and their shareholders for the faith they place in the capabilities of electricity to provide a certain, safe, and economical motive power. Of the three electrical systems at present in vogue, there is no reason why the best and cheapest in every respect should not be applied satisfactorily in this subway. The three systems referred to are respectively with overhead conductors, with underground conductors, and with accumulators. Our American friends have again and again stated that the cost of the overhead system to that of the underground is about as one to ten, and if that is correct, instead of the item £2,000 per mile appearing in the estimate for capital expenditure, only about £200 per mile for insulators, brackets, etc., will appear. This amount indeed seems ample, and it would not be surprising to find the actual cost reaching no more than half this amount. The bugbear which electrical engineers have not as yet had to contend against is the question of leakage, and a subway of this kind will not conduce to good insulation, therefore it may be found advisable to increase the capital expenditure somewhat, if by that means better insulation can be guaranteed from the start. Unfortunately, the amount of leakage cannot be foretold; if it could, the question would immediately resolve itself into a comparison of the cost of the leakage annually with the interest upon the capital expenditure undertaken to avoid leakage. It may be cheaper to have a certain small leakage than to go to any great initial expense to do away with it.

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Our meaning here must not be mistaken. There is no intention of advocating the putting down conductors in so careless a fashion that leakage will necessarily be large. This idea may be illustrated somewhat as follows: Leakage is inevitable. Assume that in a well-considered installation it is six per cent. To reduce this loss to five per cent. may be more costly than allowing it to remain at six per cent. With regard to Mr. Kapp's experimental results, the insulation test of this particular line gives no information as to a similar test on another line. This is all we know, that the insulation resistance is the resistance of a shunt circuit through which as little current as possible is desired to pass, for what does pass is waste and lost so far as the immediate work in hand is concerned. What the *minimum* insulation resistance per mile should be with overhead or underground conductors is a matter which, at present, is generally unsettled. That it should be high, all agree, but where "bad," "fair," "good" and "excellent" begin or leave off is left to individual opinion. An argument upon such a datum as this might well form the discussion of the electrical section of the London Chamber of Commerce. A point which is exceedingly interesting is to be found in the figures from which the traction resistance is obtained. In the schoolboy days of Macaulay the traction per ton was given by schoolmasters—that is, by text-book compilers and readers—as 8lb., and no doubt many a student assumes this to be about what would be experimentally found in tramway work. Those who have had something to do, practically, with such work know that it may be anything, from 20lbs. to 80lbs., according to the varying conditions of the rails. In Mr. Kapp's experiments it was between 50lbs. and 60lbs., and as we may assume the conditions to have been somewhat favourable, all future calculations as to power required must provide for a good margin of safety over and above this. In applying electric traction to the Southwark subway, the varying condition of the rails will not be so great as in ordinary street traffic, and the traction may therefore be taken as almost constant. It may be mentioned here that there seems to be an error in the figures of the report, probably typographical, in that $20 \times 230 = 4{,}600$ watts do not represent 7·5h.p. The number should be 5,600, and the pressure, instead of 230, should evidently be 280 volts. The necessary corrections being made due to the use of the overhead system, an approximate estimate of capital outlay can be obtained from Mr. Kapp's figures. We believe the results of Mr. Lineff's experiment on the West Metropolitan have been so successful as to induce the company to give the system a fair working trial, and it was for the purpose of obtaining the necessary capital to carry out the contemplated work that the company was recently registered. There is only one more point in the report upon which we would remark, and that refers to the estimated plant required. The estimate for steam power seems to be far in excess of the requirements. Two engines nominally of 45h.p. each should develop under normal working condition from 2·5 to 3 times their nominal power, and this would give from 230 to 270 actual h.p. to work the traffic. Perhaps we have misread the meaning, but it seems to us that either of the engines specified could without difficulty drive the three dynamos—at any rate, there is here an ample margin of power to satisfy any demand.

LEAVES FROM THE DIARY OF A YOUNG ELECTRICIAN.

BY BROAD BENT.

April 1, 188—.

YOUNG Electrician wanted immediately, to take sole charge of an incandescent installation.—Apply by letter, stating age, experience, and wages required, to X. Y. Z., office of this paper.

An answer to the above advertisement, which appeared in a technical journal a week ago, is the explanation of my being here. When I saw the advertisement, I repeated to myself, "'State wages required'—um, I don't quite like that clause. Why did they not say, 'Lowest tender accepted,' I wonder?" However, I am here now, and on the first page of my diary I will jot down a few particulars of the installation.

The generating plant consists of a Lancashire boiler (19ft. by 6ft.) with Galloway tubes; a horizontal fixed engine, 20 h.p. nominal (worked up to 40 h.p.), with feed pump attached, worked from an excentric on the main shaft; two 15-unit dynamos, capable of giving 170 volts and 90 amperes each, coupled in parallel and mounted on rails.

The generating station, which we call "the shed," is fortunately in the open, so that we get a little fresh air occasionally, although the installation itself is underground. The main cables (19-16s) extend to a distance of a mile and a-half to the right of the shed, and to about a mile on the left, being supported in the tunnels upon earthenware insulators, which are fixed upon iron brackets projecting from the wall. Originally the cables were fixed to the walls by "dogs," but as water is constantly trickling, and in some places pouring, down the walls, the insulation became saturated, and considerable loss of power was the result. At five points along the line the mains are "tapped," branch cables of 19-21s being connected and led away to five stations, taking on the average 60 lamps each. In the stations the cables are suspended overhead, parallel with the platforms, the lamps hanging from them at distances of about 30ft. apart. Wires are tapped on to these branch cables to feed the lights upstairs, switches being inserted where necessary, and double-pole fusible cut-outs are placed at the commencement of every circuit of three or more lights

The machinery runs twenty hours every day, so we work in "shifts" of twelve hours; a night and day shift. The average current in the daytime is about 85 amperes in the summer, and about 140 amperes at night. In winter there is very little difference between night and day currents. (Fig. 1 shows the positions of the five stations.)

April 5.—Tested the insulation of the cable this morning, after the machinery stopped (that is about 1 o'clock). Not supposing it to be very high, I used the ordinary bridge method (see Fig. 2.) I, of course, had to cut out all the stations first, which means walking through the two and a-half miles of tunnel, with a smoky hand-lamp, which has a bad habit of getting blown out just when it is most required. However, after falling over the points a few times, I got on fairly well.

I was somewhat surprised to find that the longest cables —those on the C.S. side—gave the highest insulation

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resistance; in fact, it was almost twice as much as the S.M. end. The actual figures were—

C.S. side = 19,000 ohms, when connected as in Fig. 2.
„ „ doubtful* „ „ „ Fig. 3.
S.M. side = 12,000 ohms, „ „ „ Fig. 2.
„ „ 8,000 ohms, „ „ „ Fig. 3.

The earth connection was made by soldering a wire to the water-pipe. Being then about 4 a.m., it was time to plug in the stations again and get ready for lighting up.

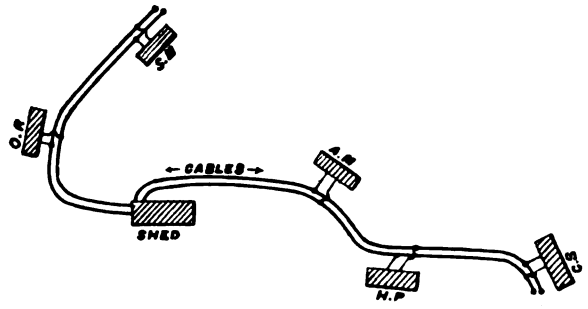

Fig. 1.

Whilst in the tunnels I examined the cables, to find, if possible, the cause of the difference in the insulation resistance of the two sections. I found that near S.M., for a distance of several yards, the wall was quite wet, and water was dropping from the roof on to the cables, the insulation of which was completely wet through. Besides this, all the insulators were covered with a thin layer of damp soot, thus forming a probable source of leakage.

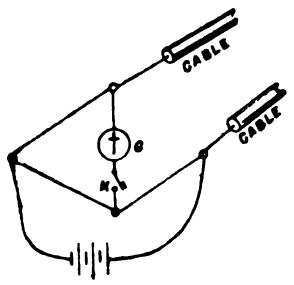

Fig. 2.

On my way back to the shed, I stumbled over a guide-rod and extinguished my lamp; not having a match I had no alternative but to accomplish the remaining distance—almost a quarter of a mile—in total darkness.

April 12.—I sent a man to clean all the insulators in the tunnels a day or two ago, and also to paint the cables from end to end with a mixture of tar, pitch, &c. This has increased the I.R. considerably, especially of the S.M.

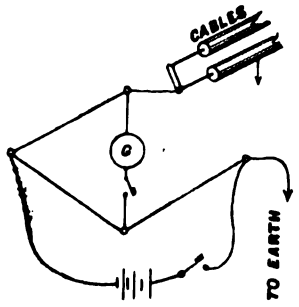

Fig. 3.

section. I should like to take the insulation resistance from lead to return of the whole installation—not the cables only, but including everything, as I think there is a loss of about 5½ h.p., when all the lamps are on, through leakage alone.

Thus the lamps are 160 volts, 16 c.p., which at 4 watts per candle is 64 watts per lamp. As $W = E C$, $C = \frac{W}{E} = \frac{64}{160} = \cdot 4$ ampere per lamp. So that when the 300 lights are on the total current should be $300 \times \cdot 4 = 120$ amperes. As a matter of fact, at the present moment the current passing through the ammeter is 140 amperes, and there are 285 lamps in use, which represent a current of 114 amperes—there is a loss of 26 amperes.

Using the formula $\frac{E C}{746} = \text{H.P.} = \frac{160 \times 26}{746}$, I find there is a loss of about 5·57 h.p., not including the fall of potential along the line, which is about 15 volts.

Unfortunately, there is not time to take the insulation resistance of "over all" and find out the weak points, as this would mean taking down the 300 lamps and replacing them all again (besides making the test) between the hours of 1 a.m. and 5 a.m., and if we chance to be a few minutes late in starting there would probably be five reports (one from each station) sent to head-quarters.

(To be continued.)

* The readings were recorded very roughly at the time, in pencil, on a scrap of paper, and this is illegible. As nearly as I remember, it was some thousands less, having only half the thickness of dielectric in circuit.—B., 1888.

ON THE PROPER SIZE OF TELEPHONE CONDUCTORS.

BY DAVID BROOKS.

The long-distance telephone company work metallic circuits of No. 16 American gauge between Philadelphia and New York, the length of conductors being slightly over 200 miles, the distance by line being 100 miles, four miles of which are under ground or water, making eight miles of conductors under ground and water. The telephones work well—far better, indeed, than the local service in the city for even as short a distance as one quarter of a mile, even if they use the same gauge conductor. With the metallic circuit, the resistance is fully eight hundred times that of these short lines. I mention this to show that conductivity or low resistance has very little to do with good telephonic service. In the one instance we get rid of inductive disturbances, and in the other we do not.

Take an ordinary circuit, say, one mile in length. Say that each receiver has a resistance of 100 ohms, and the induction coil 300 ohms, making a total of 400 ohms for the resistance of one instrument. Calling the conductor 20 ohms, we have a total resistance of 820 ohms in the circuit. Now, substituting a No. 21 gauge conductor, which has a resistance of about 70 ohms per mile, we have increased the resistance of the circuit about 6 per cent., and theoretically increased the magnetic effect 6 per cent. Now the No. 16 gauge wire has twice the surface of the No. 21 gauge, and gathers twice the quantity of inductive disturbance. It has twice the electro-static capacity, and twice the retardation, if electro-static capacity and retardation are identical.

There is no trouble hearing the voice in these short circuits in either case, but the difficulty lies in getting distinct articulation. As an illustration, we have a telegraph cable of 53 conductors on the Pennsylvania Railway, between Broad and Thirty-second streets, a distance of 1⅓ miles. Twenty-eight of the conductors are in use, mostly for telegraphic purposes. The other twenty-five are idle. Using one of the wires with the telephone, it works fairly well, but if we bunch all the idle wires at each end, and use them as a single conductor, we reduce the resistance of the conductor twenty-five fold, and we increase the inductive disturbances to that extent, and develop a noise resembling that of a million promiscuously-tuned Chinese gongs. We can get no speech over that bunched conductor.

There is another view which may be taken of the cases and the effects ascribed to self-induction, or as our European electricians now express it, "electro-static inertia." In reference to that phenomena I will quote from Dr. Oliver J. Lodge. He states: "There is a remarkable fact concerning electrical currents of varying strength, which has been lately brought into prominence by the experimental skill of Prof. Hughes—viz., that a current does not start or stop equally and simultaneously at all points in the section of a conductor, but starts at the outside first. The fact is naturally more noticeable with thick wires than with thin, and it is especially marked in iron wires. . . . To illustrate this matter further, rotate a common

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tumbler of liquid steadily for some time and watch the liquid, dusting powder, perhaps, over it to make it more visible. You will see first the outer layer begin to participate in the motion, and then the next, and then the next, and so on, until at length the whole is in rotation. Stop the tumbler, and the liquid also begins gradually to stop by a converse process." Again, he states: "We learn from all this that whereas, in the case of steady currents, the sectional area and material of the conductor are all that need be attended to, the case is different when one has to deal with rapidly-alternating currents such as occur in a telephone."

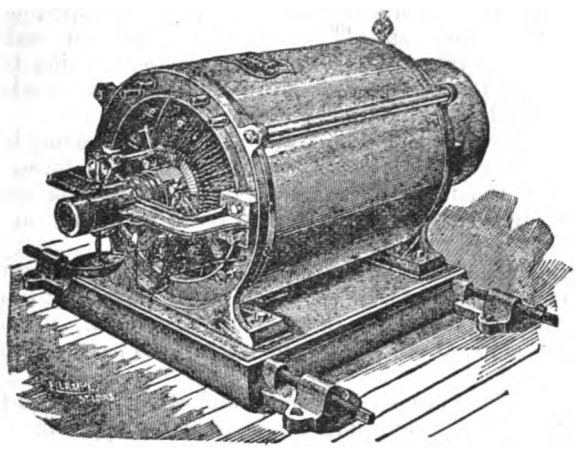
I am not familiar by practice or experiment with electro-static inertia, but infer from what I read that it is unfavourable for the use of large-sized conductors for telephone purposes. I am firmly in the belief, however, that small conductors, when used for ordinary lengths, are far preferable to those that have been heretofore employed. That for overhead wires strung on poles or housetops, a phosphor bronze conductor, on account of its strength and small diameter, is far superior to iron or copper, because it can be made with very small diameter and yet have sufficient strength and conductivity. I believe also that there have been thousands or hundreds of thousands of dollars spent for copper which could have been saved and a better service obtained by using smaller sized conductors.

Before the conductors referred to in the iron pipe were connected to the overhead conductors, a number of experiments were made with telephones, using the iron pipe for the return circuit, so as to compare its effect with that of the complete copper metallic circuit. No inductive disturbance was perceived in either case, nor did the copper metallic circuit show any advantage over the circuits using the pipe for the return current. In the centre of the cable is a smaller sized wire, No. 18 American gauge, upon which we still use telephones; and although there are heavy dynamo currents upon four of the No. 16 conductors in the same cable, or group, the No. 18 conductor for telephone purposes using the pipe for the return circuit works much clearer and better than any of the circuits of the local telephone company whose wires are strung upon poles or house-tops.

And this brings to my mind a suggestion of Oliver Heaviside, that electro-static inertia, or self induction, might be neutralised by mutual induction, since it does appear that the iron pipe has something to do with the good working of the telephone conductor.—*Electrical World.*

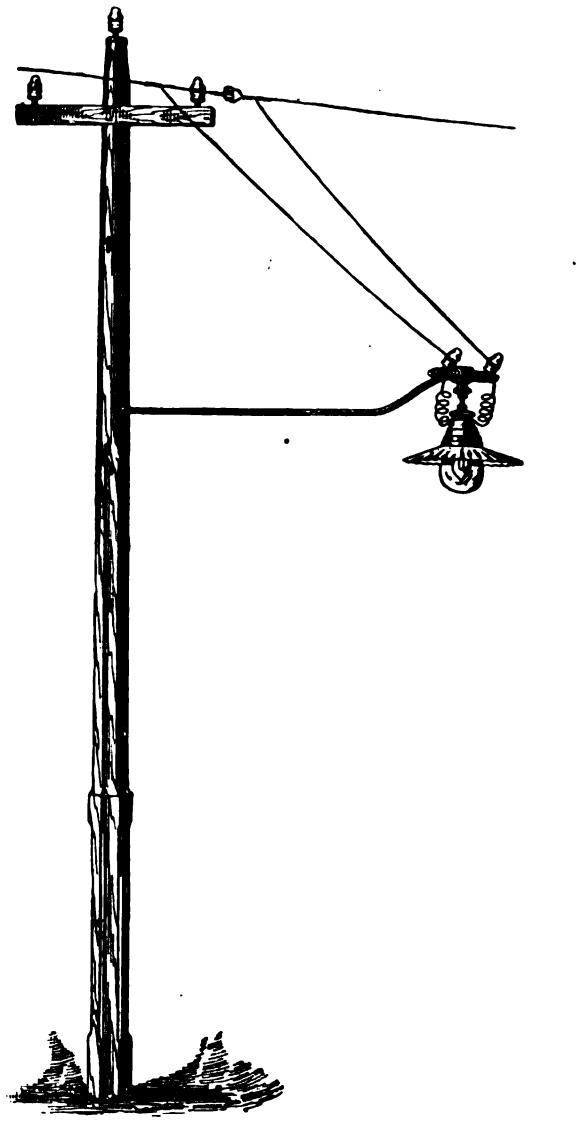
THE HEISLER SYSTEM.

The Heisler system of street lighting, now in use in several towns in America, differs from most others in this important point, that it is an incandescent system and not an arc system. We have already commented upon this system in our issue of July 20th (p. 49), and to-day we add a few particulars concerning this system, which, curiously enough, seems to be supplanting the "tower" system in some cities. The plant for the street lighting of Wabash, Indiana—where the "tower" system has been in use for over eight years—was completed recently, consisting of one hundred and thirty-two lights of 30 c.p. placed at the intersection of the streets. The circuits extend over an area of 12 miles, No. 8 wire being used throughout. The street fixtures are directly attached to the poles in substantial fashion, supported by iron castings made for that purpose, each light being at the height of about 12ft. above the ground.



The Heisler Incandescent Dynamo.

Wabash was the first city in the United States to adopt the tower system for the illumination of the streets. It was not, however, so successful as had been anticipated, the strength of the lights casting many of the streets into deep shadow, and an improvement was sought in the direction of better distribution of light by using a greater number of lights of smaller candle-power at a regular and suitable distance from each other, and of obtaining an equal amount of illumination in every part of the city, no matter how remote from the centre.



The Heisler Street Fixture.

A local company was formed for the purpose of supplying the street lights and private firms from one central station by incandescent lights on this system. The steam plant which had been used for the arc lights on the tower, consisting of a 45 h.p. engine and a 50 h.p. boiler, was turned over to the company, and has proved sufficient to supply not only the street illumination over the whole extent of the city, but also a plant of about 200 lights of 20 and 30 c.p. for shops and private residences. The local paper says: "There is no denying the fact that the present illumination is a great improvement over the tower plan, as used by Wabash for nearly, if not fully, eight years. The Heisler light is suitable for both street and indoor illumination, and the large number of lights now used insures a more thorough illumination of the city than could possibly be obtained by the other plan."

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The dynamo is shown in our illustration. It is a high-tension alternating-current machine, wound for a constant current, and automatically regulates itself if any of the lamps go out. The lamps used are nearly all 32-c.p. incandescent lamps, though 25, and 40, and 100 c.p. lamps are also used where required. They take the full current, and a bye-pass is obtained by the simple method of inserting a thin film, which is broken by the high-tension current if the lamp goes out, thus short-circuiting the lamp. A very large duty is claimed for the system, seven lamps of 30 c.p. being obtained per h.p. Twenty-four central stations have been established on this system during the last year, all of which are said to be paying.

REPORT OF MR. GISBERT KAPP ON THE LINEFF SYSTEM.

To the Chairman of the West Metropolitan Tramway Company—

Dear Sir,—I have examined and tested the electric tramway line on the Lineff system, which has been laid down for experimental purposes at the Chiswick depot of your company. The car is a small open car, fitted with a 4 h.p. (nominal) Immisch motor. The transmission of power from the motor to the car wheels is by means of a countershaft and two Renold's chains, and, in this respect, does not differ from that used on other electric cars. There are, however, two special appliances peculiar to the Lineff car. The one is a movable dash board at each end of the car, which upon striking an obstacle automatically reverses the direction of rotation of the motor, and causes the car to run back; and the other is a magnetic brake.

The object of the dash board and automatic reversing gear is to more quickly stop the car, if through the negligence of the driver it should run into an obstacle. In this case the dash board causes the brake to go on, and the motor to be reversed. The putting on of the brake is a good feature, but I do not consider the advantages of automatically reversing the motor sufficiently great to compensate for the complication which the arrangement entails.

The magnetic brake can also be put on by hand, being actuated by the same switch lever by which the driver controls the speed of the car. I consider this brake an extremely valuable feature of the Lineff car. When the car was fully loaded and running at full speed, the distance traversed after cutting off the current and putting on the brake was only 9ft. It is needless to say that no hand-brake could effect a stop in so short a distance. As it is, however, not always necessary to stop so quickly, the switch controlling the brake-magnet should be provided with intermediate contacts and resistance coils, to enable the driver to stop more slowly if desired.

The experimental line is about one-tenth of a mile in length, and is provided at one end with a crossing point, having the usual automatic switches, so that the car runs out on one side, and home on the other side. The curves are very sharp—one having only 21ft. 6in. radius—and the line is rather in a bad condition throughout, being built mostly with old and discarded rails, so that the power required to propel the car is much greater than would be the case on a good line. Although a car of that size would be usually drawn by one horse, on the experimental line one horse is hardly enough to move the car on the sharpest curve, where the pull as measured by a dynamometer reached 380lb. This is the reason why the power required to work the car as given in the appendix is rather greater than would generally have to be provided for a car of that size. I have, nevertheless, based my estimate for the plant required for the Kew Bridge-Hammersmith line upon the data obtained in my tests with the small car, in order to have ample margin of power. This estimate is given in the appendix.

The Lineff tramway system belongs to that class where the current is supplied to the car by means of a conductor placed underground, but whereas, in other systems, the metallic surface of the conductor is exposed along its whole length, and a contact brush or slider rubs along it to take the current off, but in the Lineff system nearly the whole length of the conductor is insulated, and the current is taken off at certain points, about three feet apart. At these points are fixed small saddle-shaped contact pieces, over which trails the bight of a metallic rope, suspended from shoes which pass through the slot of the channel, and are attached to a flexible beam under the car. The rope consists of a stranded wire cable protected with gunmetal ferrules, which can be easily renewed when worn. It is insulated from the shoes which pass through the slot, and the connection between it and the main controlling switches is also insulated. The rope in passing over the contacts collects the current, which is thus led to one of the main controlling switches, and from there to the motor, returning through the framework and wheels of the car to the rails. The great difficulty with all underground conductors for tramways is their insulation. A cable protected by insulation over its whole surface may be buried in the ground, and no escape of electricity can take place. If, however, the insulation is removed at certain points along the cable, so as to expose at intervals the metallic surface, electricity can escape at those points, and it is evident that the escape will be the greater the more the conductor is bared. A conductor only partially insulated cannot be simply buried in the ground, but must be supported on insulated brackets clear of the surrounding ground or masonry. Even if so supported, a certain amount of electricity is lost by leakage, and, generally speaking, the loss will be in proportion to the metallic surface exposed. Now, in other systems of underground conductors, the metallic surface is exposed from one end of the line to the other, and the leakage resulting therefrom must obviously be very much greater than with Mr. Lineff's arrangement, where nearly the whole of the conductors may be covered by insulation, and only a few inches of metallic surface are exposed at intervals. It is doubtless due to this arrangement that the insulation resistance, even after the very severe test described in the appendix, was yet found to be as high as 10,000 ohms, being at the rate of 1,000 ohms per mile. With this insulation resistance, the loss of current over a double line between Kew Bridge and Hammersmith would not reach two amperes, and the power wasted would amount to about three-quarters of a horse-power, or about 1 per cent. of the power required to work an eight minutes' traffic over this line. I know of no other underground system which comes anywhere near this in perfection of insulation.

Another advantage of the Lineff conductor is the facility with which crossings can be arranged. The conductor consists of iron piping, with a copper conductor inserted. The saddle-shaped contacts are screwed into the pipe, which is sub-divided into sections, each sufficiently short as not to be influenced by changes of temperature. Connection between adjacent sections is made by short pieces of insulated cable, and it is thus an easy matter to arrange for two conductors to cross each other without interference. Such crossings have been fitted at one end of the experimental line, as already stated; and I found the car and its collectors to take these crossings easily, the working being facilitated by the ingenious manner in which the shoe beam is attached to the underside of the car.

The direction of motion is controlled by a reversing lever, and the speed by a switch lever. Ordinarily, during the journey, the driver has therefore to attend to one handle only, by which he controls the speed and puts on the brake.

Having carefully examined and tested the Lineff system, I have come to the conclusion that it is superior to other systems employing an underground conductor, and that it will be found suitable for suburban lines having a heavy traffic.

The results of my experiments and estimates of the Kew Bridge-Hammersmith lines are given in the appendix.

Appendix to Report on the Lineff Tramway.

Object of Experiments.—The object of my examination and experiments were, in the first place, to ascertain the electrical condition of the experimental line laid down on the Lineff system at the depot of the West Metropolitan Tramway Company; and, in the second place, to estimate what amount of steam and electrical plant would be required

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to work on the same system a given line adapted for a definite traffic.

Instruments Used.—All resistances were taken by a Wheatstone's bridge and mirror galvanometer, whilst current and pressure were measured by Miller's patent ampere and volt meters, newly calibrated.

Insulation Test.—This was made by measuring the resistance between the rails, which carry the return current, and the central conductor, which carries the outgoing current. During these tests the car was placed in the shed, and that portion of the conductor which is within the shed was disconnected, so that leakage by current through the switches and various connections in the car should not interfere with the test. The insulation resistance of the whole conductor was found 25,400 ohms. As this insulation resistance necessarily depends to a certain extent upon the state of the atmosphere, and must be lower in wet weather, I determined to test it under the most unfavourable conditions possible; and for this purpose I ordered an attendant to play into the central channel from a water hose, and another attendant to throw buckets of water over the slot all along the line. Under this treatment, which was intended to imitate a heavy shower, the insulation and resistance gradually diminished until it reached 10,000 ohms, after which point there was no further reduction.

Resistance of Conductor.—The resistance of 174 yards of conductor was found to be ·170 ohms. The calculated resistance of copper wire within the pipe is ·240 ohms, so that the resistance of the iron pipe must be about ·580 ohms.

Resistance of Earth Return.—The resistance of 174 yards of earth return circuit formed by the tram rails, the girders of central channel, and the earth, was found to be ·145 ohms. This, at the rate of 1·47 ohms per mile, was very much higher than I expected to find. The probable reason for this high resistance is that the material of the rails and girders has not been specially selected with regard to its electrical properties. The rails utilised in the experimental line were worn out and discarded rails of various patterns. According to the chemical composition of steel, its resistance may vary from six times to about forty times that of copper, and it is quite possible that the high resistance of the return circuit is entirely due to the particular quality of which these old rails consist. Rails can now be obtained of steel having about seven and a half times the resistance of copper, and if this steel be used, the resistance to the return circuit need not exceed ·25 ohms per mile.

Power Test.—The car employed was an open summer car, carrying 20 passengers, besides driver and conductor. I estimate the weight of car, as fitted with a 4 h.p. Immisch motor and chain gear, magnetic brake, and other accessories, at 35cwt., without passengers. The line consists of a straight portion, a curve of fairly large radius, and a crossing point, over which occur very sharp curves, one of only 21ft. 6in. radius. Owing to the rails being worn, and originally of different patterns, the wheels ran at times on their flanges, which causes a greater resistance to the motion than would be the case on a properly-built line. To find the electrical energy required to propel the car, I observed the pressure and current whilst the car was travelling up and down the line, over the straight portion and the curve, but not over the crossing points, because when passing these the current underwent such rapid variation that it was impossible to obtain correct readings. In all there were made ten runs, with the car containing only three persons, and the average current for the straight and curved part of the line, and for the slight rise at either end, was 11 amperes, at a pressure of 231 volts on the motor terminals, when the car was travelling at full speed, or about seven miles per hour. The energy supplied to the car when running light was therefore 3·4 e.h.p. The car was then loaded with 40 cast-iron rail chairs, weighing 86lb. each, and in addition carrying two persons, the total load being 33½cwt., and ten runs were made. The average current required was now for full speed thirteen amperes, at a pressure of 230 volts on the motor terminals, corresponding to an electrical energy of 4 h.p., for a total rolling load of 3·4 tons.

Power Required to Work a Full-Sized Car.—The average electrical energy which will have to be supplied to each of a number of cars running simultaneously can be compiled on the basis of these experiments. I make no allowance for the following considerations—viz.: 1. The tractive force per ton of rolling load will be less on a properly-constructed line, with rails in good condition. 2. The efficiency of the motor and gear in a large car must be greater than in a small one; and 3. The car does not always carry its full complement of passengers. All these points tend to reduce the power required, but I leave them out of consideration in order to have an ample margin of power. A full-sized car capable of accommodating 46 passengers, and fitted with electric gear, will weigh about three tons, and the passengers, with the driver and conductor, represent an additional 3·4 tons, so that the total rolling weight will amount to 6·4 tons. The electrical energy which has to be supplied to propel this car at a speed of seven miles per hour is, therefore, $4 \frac{6 \cdot 4}{3 \cdot 4} = 7\frac{1}{2}$ h.p.

This is represented by a current of 20 amperes and a pressure of 230 volts.

Plant required for working a double line between Kew Bridge and Hammersmith, with an eight minutes' service, six or seven cars being simultaneously in motion. The gradients are only trifling, and need not be taken into account where the current is divided between several cars. The maximum current required for seven cars will be 140 amperes, and the pressure 300 volts, allowing 20 volts loss along the line. The conductor will consist of a ¾in. gas tube, with a central No. O B.W.G. copper wire or bare cable of equivalent area. The resistance of the conductor and earth return formed by the rails and channel girders will be ·75 ohms per mile. At the depôt there will be three dynamos, each having an output of 30 h.p. (electrical), and three steam-engines, each of 45 h.p. Two sets to work the traffic, and the third in reserve.

With a Four Minutes' Service, fourteen cars will be simultaneously in motion. The conductor will consist of 1in. gas pipe, with a 19 strand No. 11 bare copper cable. At the depot there will be three dynamos, each having an output of 60 h.p. (electrical), and three steam-engines, each of 80 h.p., two to work the traffic, the third being in reserve.

Capital Outlay.

In estimating the cost of plant required to operate this line, I leave out of account the cost of buildings and permanent way, as both items are approximately the same as for horse traction. The building for the machinery will be less costly than the equivalent stabling; but, on the other hand, the permanent way will be slightly more expensive for electrical traction on account of the greater care which will be required in making good electrical connection between adjacent rails and the side rails, and the central channel girders.

Thus we may take it that the total expense will remain about the same. As regards the cost of the central channel, I take this to be £2,000 per mile, which I understood is the figure arrived at by Mr. Lineff, from his actual expenditure incurred on account of the central channel on experimental line.

Cost of plant and reserve gear, including foundations and labour for a service of

	8 min.	4 min.
Central channel	£12.000	£12,000
Conductor	2,280	3,060
Boilers, engines, belt, feed-heaters, &c.	2,200	3,500
Dynamos, switch-blocks, instruments, &c.	1,000	1,500
Cars fitted with motors and gear (350 each)	2,450	4,900
Contingencies	1,070	1,540
	£21,000	£26,500
Annual Working Expenses.		
Coal, water, oil, &c.	660	1,100
Wages, including drivers	1,200	2,000
Maintenance channel and conductor, 5 per cent.	715	755
Maintenance cars (£70 each)	490	980
Maintenance steam plant, 7½ per cent.	165	265
Maintenance electric plant, 10 per cent.	100	150
Stores	200	300
Supervision and general expenses	470	650
	£4,000	£6,200

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COPPER STEAM PIPES FOR MODERN HIGH-PRESSURE ENGINES.*

(Concluded from page 144.)

A burnisher or planisher, composed of a small square piece of agate, being the hardest and smoothest substance suitable and available, is supported upon proper arms and levers, and the agate is allowed to press lightly upon the surface of the copper on the revolving mandrel. The burnisher is caused to traverse from end to end of the mandrel by means of a leading screw at any required speed. After it has traversed the whole length of the mandrel, it is automatically reversed, and commences its journey backwards. The speed of the revolving mandrel and the speed of the traversing burnisher is so adjusted or arranged that the whole surface of the copper is acted upon by the burnisher, the result being that every thin film of copper deposited upon the mandrel must be separately acted upon, burnished and compressed into a dense and cohesive sheet of pure copper possessing a great amount of tenacity and ductility, as will be seen from the results of the experiments and tests which I have made, and which will be referred to further on. The impurities or dross fall to the bottom of the tank in the form of mud, and when washed, dried, and smelted in a crucible, the gold, silver, &c., contained therein can be easily separated. In fact, during the operation of refining copper from the rough Chili bars, the finished article is automatically produced in the form of a pipe, and all the impurities are extracted and can be collected.

While I was present at the works of Mr. Elmore, the patentee of this process, four pipes were made. The mandrels had been revolving in the baths for about 170 hours, and the copper in this length of time had reached a thickness of ·198in. The pipes were taken off the mandrels in my presence, and the ends of the pipes cut off, so as to present a portion of the pipes acted upon by the burnisher. The remaining portion, or rough ends, showed the nodules, or rough copper, not acted upon by the burnisher, and was in a completely brittle condition.

It is well known that the structure of ordinary electro-deposited copper is purely crystalline, and easily disruptured under stress. The adjoining faces of the crystals, of which the whole mass is composed, appear under the microscope to be separated from each other, and have very slight cohesive power.

In order to show the effect of the burnisher upon the material, I have had the structure of specimens of pieces of copper magnified under a microscope and then photographed. One photo was taken from an ordinary piece of cast copper. A second was taken from a rolled bar of copper. The difference in these two structures is very perceptible, and plainly shows the effect of work in the shape of rolling. A third shows the structure of a piece of ordinary deposited copper not burnished, and a fourth shows the structure of a piece of copper one-third unburnished and two-thirds burnished. From these photos it can plainly be seen to what extent the crystals are reduced in size, and the cohesive power of the material increased.

To describe more in detail how the decomposition of the unrefined copper is effected, and how the deposit takes place, I may state that the unrefined Chili bars are cast into slabs of the required length of the pipe, and these are arranged longitudinally in a wooden tank, in such a manner that the faces of the slabs are approximately at equal distances from, and parallel with, the surface of the cylindrical mandrel, both at its sides and underneath it, leaving the upper side open for the burnisher to travel over. The mandrel is fitted with a properly insulated spindle, running in insulated bearings, and driven by suitable wheel gearing, &c. The whole of this arrangement is immersed, as before stated, in a bath of sulphate of copper. The mandrel forms what is termed the cathode, and the copper bars the anode, of the electric circuit. The cathode is connected with the negative pole of an ordinary dynamo machine, and the anode with the positive pole. When the dynamo is set in motion, an electric current passes through the solution, and the following chemical changes take place. The sulphate of copper is decomposed, and the sulphuric acid is transmitted to the anode, there to attack and dissolve or combine with a quantity of copper equal to that which has been liberated or deposited upon the cathode.

The electric terms used in this matter of the deposition of copper are like those for electroplating and electrotyping, and it may be as well to describe them here.

1. The terms "cathode" and "anode" are synonymous with the positive and negative poles of an electric or galvanic battery.

Then to measure the volume of electricity passed between these points the term "amperes" is used as the unit, like feet or cubic feet, for measuring in the usual mechanical sense.

2. Then for expressing the force with which the volume of electricity is propelled the term "volt" is used as the unit.

3. The resistance opposed to the electricity is measured by "ohms."

4. The work done in the electrical circuit is expressed by "watts," in the same way that in a steam-engine the power developed is expressed by h.p. To put this shortly:

$$1 \text{ ampere} \times 1 \text{ volt} = 1 \text{ watt.}$$
$$1 \text{ watt} \times 746 = 1 \text{ e.h.p.}$$

These are the electrical terms employed by common consent in all European languages in connection with this science, and there are certain facts in relation thereto that are quite accepted.

The principal one to be noted here is that one ampere of electrical current will deposit ·005084 grains of copper per second per square foot of surface in a suitable bath and under fair circumstances. At the time I had the pleasure of witnessing the tubes being manufactured, the amperes and volts were measured by Siemens's standard instruments, from which, on the above basis, the quantity of copper electrically deposited in a given number of hours could be estimated.

In this way it was easy enough to judge of the horse-power transmitted through the dynamo to deposit a given quantity of copper or a given thickness of copper pipe of a given diameter. As to quality, it was by the nature of the process almost bound to be uniform; but in this respect the photos of the magnified pieces of copper, both before and after the burnisher has been applied, and the mechanical tests I have made are the best proofs. I may describe the latter as follows:—

Two of the four pipes I witnessed being manufactured I brought to London. One of these pipes I had fitted with strong flanges properly secured in an apparatus especially made for the purpose, and tested to destruction. The other pipe I had cut into two pieces, and one of these pieces I have kept and marked A. The other piece was cut and flattened out into a sheet, from which six test-pieces were cut and prepared for making tensile tests. I also obtained from Messrs. J. Wilkes and Sons, of Birmingham, two solid-drawn copper pipes of similar dimensions, and had them cut and tested in a like manner. The piece kept is marked B.

In addition to these pipes, I obtained from Messrs. Clelland and Thornburn, the well-known coppersmiths, of Glasgow, a brazed pipe of the same dimensions, made especially for my experiments, which was also tested to destruction, together with a sheet of best rolled copper, so that corresponding test-pieces could be made to those made from the electro-deposited pipe and the solid drawn pipe.

The results of these mechanical experiments are most interesting.

Pipe A, electro-deposited, stood a pressure of 3,450lb. per square inch before it burst. The material stretched and the pipe expanded uniformly until the copper was reduced in thickness from $\frac{3}{16}$in. to $\frac{1}{16}$in.

Pipe B, solid drawn, stood at a pressure of 2,200lb. per square inch. It also expanded, but not with the same uniform character as pipe A.

Pipe C, brazed from sheet copper, also stood a pressure of 2,200lb. per square inch, and burst, as all brazed pipes do, near the line of brazing.

The tensile strength and ductility of the copper cut from pipe A is given in the following Table.

* Paper read at the thirtieth session of the Institution of Naval Architects at Glasgow, July 25, 1888, by Mr. W. Parker, chief engineer surveyor to Lloyd's Register of British and Foreign Shipping, member of council.

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TABLE A.—*Deposited Copper.*

Marks on Specimen.	Dimensions in Inches.			Tensile Strain in Tons.		Elongation per Cent.		Contraction of Area per Cent.	Remarks.
	Breadth.	Thickness.	Area.	Total.	Per Square Inch.	In 8in.	In 5in.		
A 1.	2·0	·175	·351	8·36	23·80	13·7	20·0	73	Electro-deposited copper, cut circumferentially from the pipe.
A 2.	2·0	·18	·36	8·36	23·22	13·0	17·5	68½	
A 5.	1 0	·18	·18	4·32	24·00	12·9	16·0	82	Cut longitudinally with the pipe.
A 6.	1·0	·18	·18	4·27	23·70	13·2	13·2	71	

It will be seen from these tables that the tenacity in the normal state of these three descriptions of copper—the electro-deposited, the solid drawn, and the rolled sheet—are 23¾, 20¼, and 14 tons per square inch respectively.

The very superior ductility of the pure electro-deposited copper is clearly shown by the manner of breaking, the elongation being chiefly confined to the neighbourhood of the fracture; and whereas the contraction of area at the fracture in the solid drawn copper is 12·8 per cent., and in the sheet copper 45 per cent., in the deposited copper it averages 72 per cent.

The tensile strength and ductility of the copper cut from pipe B is given in the following table:—

TABLE B.—*Solid Drawn Copper.*

Marks on Specimen.	Dimensions in Inches.			Tensile Strain in Tons.		Elongation per Cent.		Contraction of Area per Cent.	Remarks.
	Breadth.	Thickness.	Area.	Total.	Per Square Inch.	In 8in.	In 5in.		
B 1.	2·0	·195	·39	8·0	20·5	3·75	7·1	12·8	Solid drawn copper cut circumferentially from the pipe.
B 2.	2·0	·195	·39	8·0	20·5	3·75	6·9	12·8	
B 5.	1·0	·190	·19	3·8	20·0	2·90	7·0	43·6	Cut longitudinally from the pipe.
B 6.	1·0	·190	·19	3·8	20·0	3·10	7·0	36·8	

The tensile strength and ductility of copper cut from sheet copper, such as would be supplied for making pipe C, is given in the following table:—

TABLE C.—*Rolled Sheet Copper.*

Marks on Specimen.	Dimensions in Inches.			Tensile Strain in Tons.		Elongation per Cent.		Contraction of Area per Cent.	Remarks.
	Breadth.	Thickness.	Area.	Total.	Per Square Inch.	In 8in.	In 5in.		
C 1	2·0	·265	·53	7·46	14·0	45·0	50·0	44·5	Rolled sheet copper cut in the direction in which it was rolled.
C 2	2·0	·265	·53	7·46	14·0	44·0	50·0	45·5	
C 5	1·0	·265	·265	3·72	14·0	45·0	55·5	31·0	Cut across the direction in which it was rolled.
C 6	1·0	·265	·265	3·71	14·0	42·0	53·5	31·5	

The tenacities shown by the test-pieces are confirmed by the pressures at which the electro-deposited and solid-drawn pipes burst under hydraulic pressure, and, as before stated, the uniformity of the deposited material is very conspicuous.

In order to ascertain how deposited copper behaves as compared with solid drawn and ordinary sheet copper, and how its strength and ductile properties are affected by the action of heat, such as is contained in steam pressures that are now common, I have had a series of experiments made, the results of which are given in Table D.

The specimens were immersed in an oil bath while they were in the testing machine, the temperature of the oil being maintained by a gas flame; and by this means the specimens were pulled asunder at the temperatures given, which correspond with the temperature of steam at 200lb. pressure.

TABLE D.—*Table showing Effect of Temperature in Different Descriptions of Copper.*

Mark on Specimen.	Thickness.	Breadth.	Area.	Total Load in Tons.	Tons per sq. inch.	Percentage of Loss.	Temperature.	Remarks.
						p.c.	deg. F.	
P 1 ...	...	...	...	...	...	...	60	Cold.
P 2 ...	·237	2·0	·474	6·80	14·33	...	60	,,
P 3 ...	·237	2·0	·474	5·05	10·66	26	390	Rolled sheet copper.
			474	5·00	10·55	26	390	
S 1 ...	...	...	...	...	...	...	60	Cold.
S 2 ...	·192	2·0	·384	7·70	20·0	...	60	,,
S 3 ...	·195	2·0	·390	5·55	14·33	25·2	390	Solid drawn copper.
	·194	2·0	·388	6·10	15·7	...	390	
T 1 ...	...	...	...	...	24·0	...	60	Cold.
T 2 ...	·179	2·0	·358	5·50	15·35	...	390	
T 3 ...	·179	2·0	·358	5·25	14·65	...	390	Electro-deposited copper.
	·179	2·0	·358	5.45	15·2	...	390	

The results of these experiments are embodied in the preceding table, and are very interesting. The electro-deposited copper, it will be seen, as well as the solid drawn copper, stood about 15 tons per square inch, while cold rolled sheet copper broke at about 10½ tons, at the temperature of 390deg. Fahr.

Comparing these tests with the interesting series made by Dr. Kirk at Lancefield, to which I have before referred, and published in *Engineering* in December, 1887, I find there were twenty-three specimens of copper plates tested at the same temperature—viz., 390deg. Some of these were cut across brazed joints, and others clear of the brazing.

Of the nine samples which had been cut across the brazed joint, the mean tensile strength per square inch was 10·53 tons; but they varied in strength from 8·59 tons up to 12·32, or about 40 per cent., say, 20 per cent. above, and 20 per cent. below the average.

The fourteen samples that were cut clear of the brazing broke with a mean tensile strength of 11·81 tons per square inch, the variation ranging from 10·19 tons to 13 tons per square inch, or from about 10 per cent. above to 10 per cent. below the average.

Similarly comparing with the experiments made by me at the time of the "Elbe" explosion, the mean of four samples of sheet copper, at temperatures varying from 300deg. to 370deg. Fahr., was 9·93 tons.

Other experiments also go to show that ordinary sheet copper cannot be accorded a breaking strain of more than about 10 tons per square inch at the temperature of high-pressure steam, apart from the danger and uncertainty arising from brazing, which was so disastrously exemplified in the case of the "Elbe" and also the s.s. "Lahn." In the case of the electro-deposited copper, as also in solid drawn copper pipes, these experiments indicate a breaking strain at these temperatures of about 15 tons per square inch, or an increase of 50 per cent., and an absolute freedom from the dangers of brazing. This is a step in advance for which I am sure marine engineers will be grateful, and it comes none too soon, for our increasing high pressures have here discovered a weakness and danger that was bound to cause anxiety.

I find solid drawn pipes are now being made of larger diameter than hitherto, and I am not aware what the limit of their process of manufacture can go to; at any rate, there is no limit to which the diameters of the electro-deposited pipes can be made. Many other advantages are claimed for these electro-deposited pipes, which I have not investigated, but so far as steam pipes are concerned, it is obvious that absolute uniformity of density, thickness, and tensile strength, and true circular section (all of which are important qualities), can be obtained.

It is also established that copper deposited under a burnisher can be varied in tensile strength from the ordinary granular form to a material having high tenacity, and as it obviates the necessity for the steam pipes being

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put into the fire for brazing purposes, the strength and safety at high steam temperatures may be still further increased, and if so, we shall, I am sure, be further gratified.

I cannot conclude this paper, which I hope may not be without interest to the members of this institution, and to others engaged in the manufacture and use of copper pipes, without expressing my thanks to Messrs. Maudslay, Sons, and Field for the great assistance they have been to me in carrying out a number of experiments, notably the bursting of the pipes, for which special appliances had to be devised, as also for the experiments at high temperatures. My thanks are also due to the Leeds Forge Company, who placed their testing machines at my disposal, and others who supplied me with copper and the necessary assistance and appliances for conducting these investigations.

MR. BROWN AND THE DOG.

The following ballad is suggested by the proceedings at Columbia College, July 30, 1888 :—

Then Brown he read a paper, and he demonstrated there
That alternating arguments were exceedingly unfair.
No company employed him, and his motives, he felt sure,
Were thoroughly unbiassed, philanthropic, and most pure.

He had read with deepest feeling that lives were sacrificed,
And in order to prevent this, new rules he had devised.
At once, as he expected, there arose a fearful din ;
And the alternating advocates hurled weighty papers in.

He took refuge in Virginia, until the sky was clear,
And, after slaying sundry dogs, he shouted, "I am here."
He was a most persistent man, this modest Mr. Brown,
And laboured every night and day to save our mighty town.

To prove that he was honest, his "plant" was all in view,
And he called out from the audience three men, all good and true.
One man was set to measure ohms, another watched the volts,
The third to watch the other two, and carefully take notes.

The dog stood in the latticed box,
The wires around him led ;
He knew not that electric shocks
So soon would strike him dead.

"One hundred volts we'll give him now,"
The dog did not despair ;
Brown wiped the sweat from off his brow ;
The dog turned not a hair.

"Two hundred more," then Brown, he cried,
The dog did not complain ;
He knew not that his friends had died,—
That he must die in vain.

At last there came a deadly bolt ;
The dog, O where was he!
Three hundred alternating volts
Had burst his visceræ.

EPITAPH.

Every dog must have his day ;
He had his and passed away.
He never drained life's bitter cup,
Death took him when he was a pup.

LEAMINGTON.

At the last Council meeting a long discussion took place, and the following letter was read on the question of the electric lighting of the town, respecting which there has been so much public discussion both in the Council and in the press: "Midland Electric and Power Company (Limited), Leamington. July 31, 1888. To the Town Clerk, Leamington. Dear Sir,—We beg to acknowledge receipt of your favour of the 10th inst., informing us that our letter of the 21st ult. was considered by the Council, and that they have given permission for the erection of four arc lights, by way of an experiment (provided no charge be made on the Corporation), on some spot to be agreed upon, at a height not exceeding 50ft., but that the Council object to the lights being placed on the Town Hall tower, as they considered the access undesirable, and the height (100ft.) far too great, and believe that a position facing the Parade would be more suitable. The essence of our offer was that the arcs should be placed on the tower, and therefore in a position not absolutely facing the Parade, should be at least 100ft. high, and, though lent and fixed by us free of charge, should be connected to the present mains, and the current, therefore, paid for by the Corporation. We may take it, then, that the Council have given us permission to do as nearly as possible the exact opposite of what we offered to do. We do not call in question the wisdom of the Council in wishing to try the effects of four arc lamps of 2,000 c.p. each, placed not more than 50ft. high, and facing the Parade, which at its narrowest point is only 50ft. wide. We only say that we do not wish to try this particular effect a second time at our own expense. We have already, at our own expense and on our own property, tried the effect of arcs between 30ft. and 50ft. high for street lighting. There is no mistake about the light. Used as we have shown it in Wise-street, it would take the place of ten street lamps. If the Council had not given attention to this particular illustration of the power of electricity as an illuminant, they can see it any night from nine till eleven. But this is an illustration of street-lighting by arcs. What we last offered to do was to give the town an opportunity of seeing street-lighting by incandescent lamps in combination with arc lighting of open spaces. The two are quite different problems. We think it extraordinary that so substantial and extensive a building as the Town Hall tower should only be available for the purpose of housing a clock, and we cannot understand how the man who attends to the arcs can do more damage to it than he who attends to the clock ; but we accept the decision of the Council, and now withdraw our offer, and we take the opportunity to withdraw also—at all events for the present—our former offer, made some three months ago, to bear half the cost of removing the arms that now suspend the 16-c.p. lamps from the posts and to exchange them for upright lanterns and 32-c.p. lamps. Our reasons are these : We find that our motives are not appreciated. We are supposed to be madly desirous for a continuance, at any cost, of our present contract for lighting the Parade, whereas, as a matter of business, we don't care about lighting the Parade at all. As far as the Parade is concerned, our chief desire was to assist the more public-spirited members of the Council in bringing Leamington abreast of the times. The system of lighting recommended by us, we admit, was discussed in full conclave and adopted unanimously, does not appear when in practice to please the Council ; this is a matter of taste and not of electrical engineering. Still we were willing to assist the Council in any change they desire ; but every offer we make is used by our opponents as the excuse for some attack on our reputation, and some fresh outpourings of local spite and local prejudice. When we have been personally present we have had no reason to complain of the result of the discussion ; but behind our backs the matter is different. There, statements are made to our disadvantage that are unsupported by any evidence that would be received in a court of justice, and that are untrue in fact ; and no effort is made to distinguish between legitimate criticism of matters of taste and opinion, such as the method of distributing the light and the appliances by which it is distributed, and for which matters the Council are now alone responsible. The other matters for which only we are responsible — the candle-power of the lamps—we ask (and surely it is not an unreasonable request) as a condition precedent of any fresh offer on our part that the candle-power of our lamps—should be regularly tested and published at the same time and in the same way as candle-power of the gas lamps is tested and published. As we noticed that the last one-sided discussion on the electric light which appeared in the papers was unaccompanied by our letter which gave rise to it, we shall feel obliged if on the present occasion you will hand this letter to the public press after it has been communicated to the Council.—Yours truly (for the Midland Electric Light and Power Company, Limited), ARTHUR CHAMBERLAIN."

The **Town Clerk** explained the reason why the company's letter had not been read at the Council meeting, was that it was addressed to Alderman Wackrill, and therefore went to the committee of which that gentleman was chairman.

Dr. Hardley-Wilmot hoped that the letter would be published in order that the ratepayers might see how the company treated the Council.

Councillor Crowther Davies said that he should have much pleasure in moving that the interesting document just read be referred to the Watch Committee. He regretted very much indeed the terms of the letter, and as a matter of taste he regretted that it had ever been written.

Councillor Harvey seconded the motion.

Alderman Wackrill thought it would have been better to leave the letter in the hands of the town clerk.

The **Mayor** said he regretted with Mr. Davies that such a communication had been sent to the Council, and hoped that before the company wrote letters again they would take the advice of a sensible man. Their correspondence was conducted in a most foolish manner, and he was surprised that Mr. Chamberlain should have sent them such a letter. The whole question would have to be discussed by the Watch Committee.

Councillor Barter-White thought the letter should be deferred until Councillor Davies' motion came on.

The matter was, however, referred to the Watch Committee in accordance with Councillor Davies' motion.

At the close of the ordinary business the Council proceeded to consider the only notice of motion on the agenda paper, which had been placed there by Councillor Crowther Davies, and was in the following terms : "That the town clerk be instructed to give forthwith on behalf of the Corporation twelve months notice (under clause 4 of the agreement dated the 10th day of August, 1887, and made between the Midland Electric Light and Power Company, Limited, of the one part, and the mayor, aldermen, and burgesses of the borough of Royal Leamington Spa of the other part) to determine the supply of the electric light."

Councillor Crowther Davies said : I respectfully ask leave from yourself and the members of this Council to withdraw this resolution, which has just been read by the clerk, and which stands in my name. And I ask further, sir, the kind indulgence of the Council while I, in a very few words mention my reasons for that withdrawal which, I think, as a matter of respect to the Council, I ought to give. I wish, and I am sure we are all of one mind in this matter, to leave no means whatever untried whereby an accommodation may be found as between this Council and the Electric Light and Power Company. Several members of this Council have intimated to me that, anxious as they are that this notice should be given, supposing all means have failed whereby any negotiations are likely to be satisfactorily con-

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cluded, yet they desire, and I am perfectly with them in their desire, that the company shall not be able in any shape or way to say that any hasty step has been taken by this Council to put an end to the contract, but that, on the contrary, they wish that every means should be used to bring about a satisfactory state of things, and one which will allow all means to be taken to make Messrs. Chamberlain and Hookham's venture in the town a successful one, and one that would redound to their credit as electricians, and to the satisfaction of the ratepayers of the borough in providing them with a brilliant, and an economical, and a real electric light. A letter has been read to-night to this Council from Mr. Chamberlain. I wish to say no harsh words about that letter. I wish merely to say this, that it is undoubtedly a most unfortunate one, but unfortunate only for the writer of it, and not for its recipients. (**Councillor Johnson:** It is a very rude letter.) Mr. Chamberlain has formed a most unjust and unworthy conception of this Council as a whole, and of some—if I may be permitted to say so—of its individual members. Perhaps, if this resolution is withdrawn, which I, sir—and Mr. Chamberlain might know if he were in this room—could carry if I willed, perhaps Mr. Chamberlain will come to the conclusion himself, that he would do well to treat us as reasonable men, as just men, and as honourable men, and as desiring by no means to throw cold water on his company, but trusting that he and his company may see fit so to meet us that we, with due regard to the interests of the ratepayers, may also meet them. I hope if this resolution be deferred for a period, Mr. Chamberlain may be found amenable to reason. His forte, whatever it may be with regard to electricity, does not at any rate extend to the writing of letters. If he will see us, or you—if he will see those to whom this matter may be deputed, and act as a reasonable man—he will have no cause of complaint, I am quite sure, of any treatment of ours in the future. I ask respectfully the leave of the Council to withdraw this resolution.

Councillor Bright: I beg to second that proposal, and to compliment Mr. Davies on the conciliatory way in which he has treated this subject. It is the more generous, as it is patent to all of us that there is in this room at this time a majority of the gentlemen who formerly voted for that resolution. Mr. Davies is consequently quite right in saying that if he chose to press this motion he might carry it; and I certainly compliment him that, having that in his power, he treats the question, as he has done, in such a gentlemanly way. It is the more generous, because he must have felt, as a great many of us feel, the sting of that extremely unwise letter read by the town clerk. I hope that it will not be thought by those gentlemen either that we have been affected by that letter, or that we are satisfied with what they have given us in the way of electric light. As one of the promoters of that light, I say myself that they have not given us that light that we, as a Council, ought to accept for the town. I have no hesitation in saying that when I voted for the introduction of the light—and I believe I was the proposer of the motion—into Leamington streets, I did not vote for such an extraordinary illumination as they have given to us. The fault is not in the electric current, I am satisfied, although when first laid down, as it happens often with new installations, the fault frequently did lie with the current. That has been remedied, and the fault now lies in the lanterns, which I say, according to the contract, are not our property, but the property of the Electric Lighting Company. The standards are put, some in one direction and some in another direction. The standards as a pattern are according to a plan which was deposited with this Council, and in reference to them we are responsible as well as they for the ugly structures we have now. But the lanterns we are not responsible for. They are provided by the Electric Light Company, and I say that by Clause 5 in their contract they are to remain their property. I believe—and I should not say it if I did not believe it—that with a very trifling alteration we can make this installation perfectly satisfactory to us, and perfectly satisfactory to the ratepayers of Leamington. I feel sure that the incandescent light can be made—and with very little cost—to give such a diffusion of light in our streets as would be infinitely superior to gas, and at no greater cost. But that is not the case with the lanterns supplied by Messrs. Chamberlain. Part of these have metal tops and reflectors. You go a yard or two and there is another with a porcelain top. No installation, and especially an installation for a town of the importance of Leamington, ought to be of this magpie order—one one pattern and another another, one in one direction pointing north, another east, and another south, so that looking up the street from the bottom you see a sort of wavy line of little lights, some of them much brighter than others, inasmuch as those with porcelain tops allowed the light to pass through them while the metal tops obstructed it.

The **Mayor**, interrupting Councillor Bright, said that as Councillor Davies wished to withdraw the resolution, he could not allow any discussion.

Councillor Bright: I am seconding the withdrawal of the motion.

The **Mayor:** It is unnecessary to have a seconder.

Councillor Bright: I bow to your decision, sir.

Councillor Purser remarked that he thought it was unfair, having had speeches on one side, not to hear those on the other.

Councillor Davies said that, supposing after the interval of a month or two no means of accommodation were found between the Council and the company, he should consider it his duty to renew the resolution. He did not want the ratepayers to think he had in any way retreated from his former position. He wished to be more than fair to the company, but he did not intend to allow the matter to go on indefinitely.

The Council agreed to the withdrawal of the resolution, and the **Mayor** suggested that the whole question be referred to a committee of the whole Council for full discussion.

Alderman Gilbert proposed that the matter be referred to a committee of the whole Council, and that Messrs. Chamberlain and Hookham be asked to meet them and confer with them on the subject during the ensuing month.

The **Mayor** suggested that the committee should first discuss the question, and having arrived at some decision should consult Messrs. Chamberlain and Hookham afterwards. A feeling of irritation had very naturally been caused amongst the members of the Council as business men by Mr. Arthur Chamberlain's letter, and he thought it would be better to defer the consultation with the company until all that feeling had passed away.

Alderman Gilbert amended his motion as suggested by the Mayor, and it was then seconded by **Alderman Wackrill,** who advised that the letter should also come before the committee.

Councillor Purser remarked that he should like to add that the speeches which had led up to that letter be also considered. If they had had three months ago such conciliatory speeches as they had heard that day, he felt convinced that they would never have had such a letter from Mr. Chamberlain. That letter was only the result of speeches delivered there formerly, which he had been very sorry to hear. He did not know what the majority in favour of Mr. Davies' motion was. He supposed someone had been round and got to know the opinions of the members of the Council. He did not know how members would have voted, but he supposed someone else knew. He hoped the question would be dealt with on its merits when it came before the General Purposes Committee.

Councillor Davies remarked that as to the previous speeches on the subject, if they had been untrue, no doubt they would have been exposed ere that time. He stuck to every word he had said about the electric light, and was prepared to substantiate it. He was not in the habit of saying one thing one day and backing out of it the next. He must say he thought it was invidious to speak of past speeches when the desire had been shown by Councillor Bright and himself to place the matter in such a position that it could be calmly and properly discussed in such a temper which would become and benefit the subject and both parties interested. With regard to the letter, for his own part he should have ignored it, and have put it behind the fire, and have forgotten it. Of course, if the Council wished to keep the letter in its archives as a specimen of what an irritable and foolish man could write, by all means let them do so.

Alderman Gilbert's motion, that the matter be referred to a committee of the whole Council for discussion, was carried, and it was agreed that the meeting should be held at an early date.

Councillor Purser moved that the Lighting Committee take means to ascertain the amount of light given by the electric lamps in the streets.

The **Mayor** suggested that that resolution, which dealt with a very important matter, should be considered by the committee of the whole Council when they went into the whole question.

Councillor Barter-White: I object to its being adopted now.

The **Mayor:** You can't object now. It will be a matter for the Corporation to vote upon.

Councillor Bright asked the surveyor if he had any apparatus by which he could test the electric light if it was fitted up.

The **Surveyor** replied that there was an apparatus which, at a cost from £10 to £12, could be fitted up to test the electric light.

Councillor Salmon seconded Councillor Purser's motion, and remarked that he thought they ought to get to know all they could about the light, and that some steps should be taken to have it tested, even although it might vary. They would be able to arrive at a better estimate of what the light really was by having it tested.

Councillor Davies asked why they could not meet on a common ground. It had been proposed to the Company that they should furnish a test, and they instantly refused to do anything of the kind. But what sort of test did they propose to have. Did Councillor Purser delude himself with the notion that the test applicable to gas was also applicable to the electric light? A gas test showed the quality of the whole volume of gas at that time in the gasometer, but as to the electric lamps he could take Councillor Purser to one lamp and have it tested, and it might register 20 c.p., and he would take him ten minutes after, and he would find it had very considerably diminished. Any such test would, therefore, be utterly fallacious.

The **Surveyor,** who was appealed to by **Councillor Davies,** confirmed his statement with regard to the test.

Councillor Purser said he had never mentioned a gas tester at all. He wanted to know the average light of the whole lamps on the Parade, and to see whether they were under or over the power contracted for.

The resolution was lost by six votes to three.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ended August 17, 1888, amounted to £4,596.

Western and Brazilian Telegraph Company. — The traffic receipts of the Western and Brazilian Company for the past week, after deducting the "fifth" of the gross receipts payable to the London Platino Brazilian Company, were £3,813.

West India and Panama Telegraph Company.—The estimated traffic receipts of the West India and Panama Telegraph Company, Limited, for the half month ended 15th inst. are £2,533, as compared with £2,048 in the corresponding period last year, showing an increase of £485.

West Coast of America Telegraph Company.—At the usual meeting of the Directors of the West Coast of America Telegraph Company, Limited, Mr. Frederick Walters, of 12, Tokenhouse-yard, E.C., and partner of Messrs. Huth and Co., in Valparaiso, was elected to a seat at the Board.

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PROVISIONAL PATENTS, 1888.

AUGUST 10.

11,529. **Improvements in electric lighting.** William Towle, Midland Grand Hotel, St. Pancras, London, and William Edward Langdon, Midland Railway, Derby.

11,544. **Improvements in electrical coinfreed machines.** James Gilbert Cumming, 7, Union-street, Edinburgh.

11,561. **Improvements in gas incandescent lamps.** Edmund Ritter Klein von Ehrenwalten and Carl Fabricius, 28, Southampton-buildings, London, W.C.

11,568. **Improvements in electric batteries.** William Shedlock, 45, Southampton-buildings, London.

11,569. **Improvements in secondary and other electric batteries.** Henri Pieper, 47, Lincoln's-inn-fields, London, W.C.

11,570. **Improvements in electric arc lamps.** Henry Pieper, Fils, 47, Lincoln's-inn-fields, London, W.C.

11,573. **Improvements in electric lamps.** Henry Head and Llewellyn Saunderson, 24, Southampton-buildings, London, W.C.

AUGUST 11.

11,582. **Improvements in apparatus for the electro-deposition of metals and for the separation of chemical compounds or bases therefrom.** Frederick Henry Varley, 2, Victoria Mansions, Westminster, S.W.

AUGUST 13.

11,681. **Improvements relating to electric batteries and to exciting liquids or compounds therefor.** E. Liebert and Sally Adolf Rosenthal, 45, Southampton-buildings, London. (Complete specification.)

AUGUST 14.

11,703. **Improvements in electric dynamos and motors.** Edward Crowe, Grove Hill, Middlesbrough-on-Tees.

11,705. **Improvements in apparatus for measuring electric currents, and recording the amount of electric energy consumed in a given circuit.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Westinghouse Electric Co., United States.) (Complete specification.)

11,718. **An induction apparatus—a substitute for dynamo-electric machinery—for the generation of electricity, without converting the energy of mechanical motion into the energy of electric currents—i.e., without moving coils of wire past magnets or magnets past coils of wire.** Joseph Gozo, 41, George-street, Portman-square, London, W.

11,737. **Improvements in electric bell pushes.** Gustav Binswanger, 5, Gt. St. Thomas Apostle, London, E.C.

AUGUST 15.

11,749. **Improvements in the manufacture of carbons for electric lamps.** John Scudamore Sellon, 47, Lincoln's-inn-fields, London.

11,766. **An improved electro-ozone producing apparatus.** Francis James, 45, Southampton-buildings, London.

11,779. **Improvements in galvanometers.** Edouard Emmanuel de Facieu, 33, Chancery-lane, London. (Complete specification.)

11,782. **Means for disengaging the regulating mechanism of electric arc lamps and clockworks which disengage by electricity.** Eduard Correns, 89, Chancery-lane, London, W.C.

AUGUST 16.

11,798. **Improvements in fittings for electric bells.** William Woodall, trading as James Macintyre and Co., 23, Southampton-buildings, Middlesex.

11,809. **Improvements in electrometers and apparatus for measuring the electric potential of the earth and of its atmosphere, and of any other body or gas.** Arthur Hill Maurice, Lacelles Carr, and Daniel Owen, Cardiff, Glamorganshire.

11,817. **Improvements in electric furnaces.** John Covert Hobbs, Cleveland, Ohio, Cuyahoga, United States. (Complete specification.)

11,858. **Improvements in electric batteries.** Owen Charles Dalhousie Ross, 8, Quality-court, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

OCTOBER 10, 1887.

13,720. **Apparatus for effecting electrical measurements and contacts.** Achilles de Khotinsky, 28, Southampton-buildings, Chancery-lane, London, W.C.

NOVEMBER 11, 1887.

15,455. **Apparatus for connecting a number of separate electrical conductors to one main conductor.** William Snow Rogers, 28, Southampton-buildings, Chancery-lane, London, W.C.

JANUARY 17, 1888.

713. **Improvements in voltaic or galvanic batteries.** Theophilus Coad, 10, Thorpe-terrace, Thorpe-road, Forest Gate.

MAY 24, 1888.

7619. **Primary electric battery.** George James Weir, 22, Renfield-street, Glasgow.

SPECIFICATIONS PUBLISHED.

1887.

10,131. **Meters for electricity.** G. Forbes. 8d.

10,157. **Transmitting, &c., electrical signals.** T. A. Garrett. 8d.

11,252. **Secondary batteries.** H. Mower. 8d.

11,901. **Lamp holders for incandescence electric lamps.** R. A. Scott. 8d.

12,015. **Incandescent electric lamps.** W. Löndholdt. 8d.

12,683. **Spongy lead for electrical accumulators.** F. M. A. Laurent-Cely. 8d.

12,718. **Electrical speed indicators.** J. Tate. 8d.

1888.

4221. **Holders for incandescent electric lamps.** T. Coad. 6d.

7852. **Electric distribution.** (Westinghouse, jun.) 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday.
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	3½
12 Feb.	2/0	— fully paid	5	4½
27 July	1%	Anglo-American	100	40½
27 July	2%	— Pref.	100	67½
12 Feb., 85	5/0	— Def.	100	18½
28 June	3/0	Brazilian Submarine	10	13⅝
14 June	1/0	Con Telephone & Main	1	⅝x
10 Aug.	9/0	Cuba	10	18½x
10 Aug.	10/0	— 10% Pref.	10	18½
28 Mar.	2/2½	Direct Spanish	5	4
28 Mar.	5/0	— 10% Pref.	5	10
27 July	2/0	Direct United States	20	9⅛
27 July	4/6	Eastern	10	13⅛
27 July	3/0	— 6% Pref.	10	14¾
1 Aug.	5%	— 5%, 1899	100	108½
26 April	4%	— 4% Deb. Stock	100	106½
12 July	2/6	Eastern Extension, Australasia & China	10	13⅛
1 Aug.	6%	— 6% Deb., 1891	100	103½
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	102
28 Mar.	8/3	German Union	10	9½
10 Aug.	3/0	Globe Telegraph Trust	10	6⅞x
10 Aug.	3/0	— 6% Pref.	10	14
30 April	5/0	Great Northern	10	14¼
1 Mar.	5%	Gt. Northern 5% Deb., '83.	100	108
27 July	10/0	India Rubber, G. P. & Tel.	10	17½
11 May	37/6	Indo-European	25	38
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
		Swan United	3½	2⅛
10 Aug.	13½%	Submarine	100	150
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39½
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	5½
1 Mar.	5%	— 5% Debs.	100	95
12 July	4/0	West Coast of America	10	6½
30 June	8%	— 8% Debs.	100	117
11 May	9/0	Western and Brazilian	15	11⅜
11 May	6/10½	— Preferred	7½	7
11 May	2/1½	— Deferred	7½	5¼
1 Aug.	6%	— 6% A	100	113
1 Aug.	6%	— 6% B	100	108
		West India and Panama	10	1½
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80		— 6% 2nd Pref.	10	7¾
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	104

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NOTES.

Washington.—The House, at Washington, has appointed a special electrical engineer to make plans for lighting and to solicit tenders.

Harold P. Brown and the Dog.—The poetry on this subject, which appeared in our last issue, should have been credited to the *Electrical Engineer*, of New York.

Four Virtues.—The electric motor, says one user of them, is (1) clean, (2) noiseless, (3) compact, and (4) cheap. This is the sort of character for a go-ahead article.

Electric Light Posts Wanted.—Mr. Massingham wants 240 iron posts for his Bath lighting scheme. Particulars can be found in our advertisement columns.

Who Invented Electric Welding?—Dr. Otto Moses, of New York, is contesting Prof. Elihu Thomson's claim as the inventor of electric welding in the New York courts.

Richmond, Va.—The Sprague Company are running an extra two miles of double track of electric road to carry passengers into the exhibition, commencing on October 3. The company have bought up the rival horse-car road, and will apply electricity to the whole system.

Dover.—At the last meeting of the Council a letter was read from Messrs. Laing, Wharton, and Down, asking the Council to consider the question of lighting the streets of Dover with the electric light, and the consideration of the question was adjourned for one month.

Saving Their Fuel.—The St. Lawrence Marble Company are anticipating making a saving of £1,000 a year in fuel by using the water power in the St. Lawrence by means of a dynamo and motors for driving the machinery at their quarries, at present driven by a 100 h.p. steam-engine.

Shocks from the Letter-Box.—In one town where electric light is used, a letter-box is attached to one of the poles. A lady who attempted to post a letter here was discouraged from further attempts by a very fair shock. A gentleman lifted the lid and pushed the letter in with his stick.

Dictionary of Electricity.—A work is announced by Prof. Houston, giving definitions of electrical words, terms and phrases. This should prove very interesting and useful. If French and German equivalents were given in addition, its usefulness in technical hands would be much increased.

Electrical Treatment of Sewage.—Iron seems to be the only material of practical value, according to Mr. Webster's experience, for positive electrodes in his treatment of sewage. He has therefore filed an amendment limiting the patent to the use of positive electrodes of iron, except in the case of the filtering process.

Rawdon.—The township of Rawdon, it appears, has no public lighting. A scheme of gas lighting last week was submitted to the Local Board, the cost to be about £2. 10s. each for 104 lamps, and the cost £1 each for maintenance per year; but the project was rejected. If anyone wishes to convince the Local Board of the benefit of electric light, now is the time to try it.

An Electrical Society for Japan.—Under the presidency of Viscount Enomotto, Minister of the Department of Communications in Japan, an electrical society has just been formed, and already numbers more than 800 members. The chairman of council is Mr. R. Shida, who is local honorary secretary of the Society of Telegraph Engineers and Electricians in Japan.

Train Lighting.—We notice that the Lancashire and Yorkshire Railway have not been able to determine upon the provision of the electric light for their travellers, and, after conducting some experiments with the electric light, have finally adopted a patent gas for their carriages. It is claimed that it is better and cheaper than oil lighting, and is more economical than electric light.

Its only Rival.—The only final rival to the Tesla motor is the Keeley one; that would beat it, if it would work. The Keeley Company have called upon Mr. Keeley officially to disclose his secret, or henceforth and for ever hold his peace. He offered to do this eighteen months ago, and now is compelled to do so, or fall. And he cannot do it. The Keeley "motor" won't "mote."

Gilchrist Engineering Scholarships.—An entrance scholarship will be offered at University College, London, in the month of September. The value is £35 per annum, tenable during two years, and the competition is limited to those who have not previously been students of the college, and who will not complete their nineteenth year before October 1. A senior scholarship of £80 will be awarded at the close of the session.

Motors on Arc Circuits.—The Baxter motors are worked successfully on arc circuits in the States without interfering with the steadiness of the light. There is no difficulty about it. Our pushing electrical engineers might note that arc or incandescent, alternating or direct, motors will now work on all circuits. They will hoist and ventilate, and turn lathes or heavy machinery. The motto for electrical managers should be: "Fill up the valley of the load diagram."

Electrical Thief-Catching.—A bit of neat thief-catching comes to us from St. Louis. There had been a considerable amount of petty thieving going on at one of the electric light stations, but the thief could not be caught. The following electrical remedy was tried. A large piece of brass was laid in the window-sill. This was connected to a 20-light circuit, known to be slightly grounded. In due time the thief arrived. He caught at the bait, and in less time than it takes to tell it he was landed in the centre of the street. Nothing has been missed since.

The "Great Eastern".—The poor old "Great Eastern"! She is to go to the knacker's yard at last, and is to be broken up and sold as old iron. First built with the idea of revolutionising the ocean trade, after an unsuccessful run she was utilised for cable-laying, and now, after having fallen to the *role* of a floating palace of varieties, and failing in this as in other functions, she is to be broken up and the machinery sold. Someone ought to have tried at getting up a company for using her machinery as a floating electric light station, and failed—with a large profit—and her misery and uselessness would have been then complete.

Cost of Telephone.—According to a series of statistics given by *La Cote Libre* of Brussels, the cost of telephones in France varies according to the length of the lines from £14 to £24; in Germany it is £10 for a line of two kilometres, with £2. 10s. added for each kilometre; in Austria it is from £10 to £15, in Belgium and Spain from £8 to £12,

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in Italy £4. 12s. to £7, Norway from £4 to £8, Sweden £6. 8s. to £10. 16s., in Switzerland from £4 to £10, in Holland £10, in Luxemburg £3. 4s., and in Portugal £15 for merchants and £7 for individuals. In England the cost is £20, and in Russia £25. We are thus in the unenviable position of being last but one in the class.

Secured a Gold Mine.—"It is safe to say," says the *Pittsburgh Post*, "that the Westinghouse Electric Company has a gold mine in its new electric motor. The public, even the electric public, has not yet reached a realisation of the importance of the invention. The motor was invented by Nikola Tesla, a native of Lika, a town on the border line of Austria and Hungary. He was educated in Austria, and graduated as a civil engineer. Electricity soon claimed his entire attention, and now, though apparently less than 30 years of age, he has a very wide reputation as an electrician. The Westinghouse has contracted for his patents on the new motor, and he has been in Pittsburgh several weeks proving all he claims for his invention."

Better than Candles.—"The King's palace has been urnished with Edison's electric light, which has been found better and more economical than candle and kerosene." This is an item of intelligence from our consul at Corea. We envy, says the *Daily News*, the Coreans their surprise on finding that candle-light, or even kerosene, could be eclipsed by modern methods of illumination, and felicitate Mr. Edison on the enlightening effect his incandescent carbons must have had upon a country which has only recently proposed to open itself up more freely to foreign commerce. Perhaps America and Europe may have a few more surprises in store for the Coreans if allowed to prepare them; while Corean products, which appear to be mainly gold, beans, and the medicinal root ginseng, would have their value as exchange.

Alexandria.—At a meeting of the Shipping Committee of the Hull Chamber of Commerce, Mr. J. Atkinson presiding, it was stated that the Khedive proposes to render Alexandria Harbour more available in stormy weather, as well as at night, by widening it 300ft., with a depth of 30ft.; and also lighting it with the electric light, on condition that the shipping trade will contribute for twelve years at the rate of 4½ to 5 paras per registered ton—which is equal to £1. 5s. 6d. for every ship of 1,000 tons register. It was eventually proposed by Captain Hedger, and seconded by Captain Hill, that the proposed facilities at Alexandria were such that it would be advantageous when the work had been completed for shippers to enter into arrangements such as those suggested in the communication received from the Khedive of Egypt.

Gratuitous.—"Mr. C. B. Harness will esteem it a favour if you will kindly insert this editorial in your next issue." With this request comes a printed slip and a lithograph letter, the former of which is the proposed editorial. Similar letters have, we presume, been freely distributed; at least, we have had the good—or bad—fortune to have received three separate copies of the circulars. It may save future trouble and expense to say that we have our own opinions about editorials, and we express our own opinions; we neither ask nor expect that opinions upon electrical questions shall be put into our mouths by parties interested in the sale of goods criticised in these columns editorially. There is a large class of people who buy goods because such goods are extensively advertised. We believe in advertising, but we also very strongly believe in having value for our money.

The Liverpool Company's Excursion. — On Saturday last the employés of the Liverpool Electric Supply Company, Limited, had their annual excursion, Blackpool, in this instance, being the rendezvous of the party. After two hours' preliminary examination of this interesting watering place, the company met at the Derby Hotel, where an excellent dinner was provided. At the conclusion of the dinner, Mr. B. N. Collins, the secretary, took the chair, and while commenting on the steady progress of the company's operations, referred to the improved outlook for electric lighting, not only in their own district of Liverpool, where it is already being well taken up, but throughout the country generally. Votes of thanks and congratulations were proposed to the managing directors, Messrs. Holmes and Vaudrey, seconded by Mr. A. Clough, the foreman, and enthusiastically received by those present. After several hours' further examination of the various interesting sights at Blackpool, finishing with a concert in the evening at the hotel, the party returned to Liverpool, having spent a most enjoyable day.

Transformer Patents in America.—The Westinghouse Company, having entered a suit to prevent the Sun Electric Company from using transformers under Gaulard and Gibbs' patents, the court has decided that the defendants, using a multiple arc transformer system, do not infringe the patent. The original patent covered all forms of converters. The Patent Office considered this too broad a patent, and instructed the applicants that they must conform the arrangement of converters to the series system, that being the arrangement shown in an article in *Engineering*, of March 2, 1883, which the applicants declared contained a description of their invention. A disclaimer was accordingly inserted. The court now holds that it is too late for the plaintiff to say that the disclaimer means nothing; that by the disclaimer Gaulard and Gibbs were expressly limited to the series system, and therefore that the defendants, who used the multiple arc system, do not infringe the patent. The court accordingly decided, without entering upon other defences raised, that the bill should be dismissed.

Miners' Lamps Ordered.—Mr. Rees has again exhibited his miners' lamp to the members of the Cardiff Exchange, and stated that the lamp had been thoroughly tested at Lewis's Merthyr Collieries, and that the manager, after this test, "strongly recommended it for colliery purposes as the best he had seen." This gentleman, in his letter to Mr. Rees, said "the mechanism is simple, the lamp is perfectly safe, the light under no circumstances coming in contact with the air or gas. It gives the amount of light you (Mr. Rees) states, and it burns without diminution of light, having also the great advantage, not possessed by any other lamp, of thoroughly lighting the roof." This letter was accompanied by a very substantial order to Mr. Rees to supply a number of his lamps for the Lewis's Merthyr Collieries. Other colliery proprietors, having examined the lamp, are satisfied with its action, but object to the price (30s.) as compared with 6s. of the usual lamp. Mr. Rees stated that, when tested at Lewis's Merthyr Collieries, one of his lamps gave light more than equal in power and brilliancy to that given by eight of the "Protected Cambrian" lamps placed in a line across a heading—a statement the accuracy of which was vouched for by Mr. J. L. Phillips.

Cheltenham.—The determination of the Bath authorities to adopt the electric light has led the Cheltenham

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authorities to give considerable attention to the proposal to light their own town by the same means. The statement has appeared to the effect that it is intended to light the town with 36 arc lamps in place of the 170 present gas lamps at an annual cost of £444. This is the present price for gas lighting, and Mr. Denny Lane writes to point out that this statement is not correct. He says: "The present cost of the 170 gas lamps is £444, or £2. 12s. 3d. per lamp, and the committee suggest that the contractors who now supply 70 lamps to the Corporation of Bath at £18. 17s. 6d. per lamp, should be asked to supply 36 lamps to Cheltenham at the same rate per lamp, which would amount to £679. 10s., and not £444. I must remark that it is highly improbable that 36 lamps could be supplied at as low a rate as 70, since I believe there would be little difference in the skilled labour and attendance for either installation, which would have to be divided over only half the number of lamps at Cheltenham. I may add that it seems unfair to gas companies that corporations should have the power of contracting with them for only three years, while at Bath the contract for electricity extends to seven." It is stated that the authorities have decided to light a portion of Cheltenham with electric light.

High v. Low Tension.—The battle of the high and low tension systems is likely to wage very fiercely in New York when the Westinghouse Company gets fairly to work in that city. One of the first large central distributing stations for electric light was that of New York, where the Edison system was installed upon a large scale. The Westinghouse high tension transformer system has spread itself far and wide over the States, and now essays to compete for favour in that city on a scale commensurate with its necessities. A large station is now in progress, and the owners of the low tension system are becoming alarmed. The grand discussion upon the danger of high-tension alternating currents, and the experiments upon dogs to which we have alluded are to be taken as the outcome of attempts on the part of the low-tensionists to keep the lighting in their own hands by an appeal to the element of danger in the opposing system. The Westinghouse is no mean rival, and the Edison Company will have to get on their mettle to the utmost to hold against them. They have now over 100 central station plants successfully working, and have an advantage in the public eyes in their alternating current meter, which registers directly in lamp hours, and has a mechanical movement. The Westinghouse Company have now, also, a very great pull in their possession of the Tesla patents for alternating current motors, and there is no doubt a very sharp commercial battle will be waged. The station in progress is for 50,000 lamps.

Gas not Doomed.—"Whatever progress the electric light may be making, at all events it has not interfered with the progress of gas." Such were the words addressed by Mr. Edward Lawrence, chairman of the Liverpool United Gas Light Company, at the last meeting of the shareholders; and with good grounds for the assertion. In the year 1883 "B" stock of the company, when publicly sold, brought, on the average, £125. 8s. 10d.; in 1884, £131. 2s. 5d.; in 1885, £150. 6s. 6d., while recently £50,000 of that stock realized, on the average, £153. 5s. 1d. per cent. This continuous increase in the value of gas stock, thinks the *Gas World*, effectively answers those prophets who say that gas, as an agent for lighting, is doomed, and that electricity is the "light of the future." We may add our opinion to that of our gas contemporary that gas may not be doomed, and yet electricity may be the light of the future. Horses were doomed—by the prophets—when the steam-engine was introduced. Now more horses than ever are used, though horse travelling is not the usual method of rapid transit. It comes simply to this, that, as Emerson puts it, more can be bought for a dollar in one age or one country than in another where material progress is less developed. In Florida a dollar will buy you oranges galore, but not fifty miles an hour travelling, or cheap clothes. Gas will not be doomed, but the dollar will buy more and more of it in the future. It may be used for all and sundry purposes for which at the time it was invented as an illuminant it could not possibly have been utilised were the dollars brought in sacks, and the user been as full of wants as the importunate widow, simply for want of the material means of utilising. Cheer up, Mr. Gasman, your per cents. will be all right, but you had better leave the "light of the future" to us, after all.

Electrical Industries.—In a leader upon the extension of electrical industry, the *Globe* wonders how it is that electrical tramways have not attained a more extended use in England, remarking that the parliamentary difficulties experienced in electric lighting did not apply to electrical traction. It instances the telpher line at Glynde as being very successful in its action, and is surprised that the same system has not been adopted in other places where transport is difficult. What, it asks, have electrical engineers been doing during the last few years? and thinks it is not very far wrong in answering that they have been preparing and waiting for the good things coming. The Act of 1882 has certainly had a good effect in more than one way. It has prevented an immense amount of useless speculation in electrical matters, and it has given time to the electrical engineer to work out problems which were hardly given a passing thought six years ago. If electric lighting had come into general use, there is not the least doubt that there would have been some dreadful failures. We should have had "jerry" work in the wiring of houses, besides endless breakdowns in the generating station. The long interval during which the public has had to wait for the modern light has given time to train the men in their respective duties. Early in the year the president of the Society of Telegraph-Engineers said that about 5,000 persons are employed in London in manufacturing electric light machinery. What becomes of all this plant nobody seems to know. Of course large quantities are sent abroad, even new mining towns in South Africa being lit by electric light. Now that the new Bill has passed through Parliament and received the Royal assent, we may expect to see central stations established in all our large towns, and, indeed, where water-power is available, in our small towns too. The time has now come, adds the *Globe*, when we may expect to see electrical science advance with rapid strides, but the "mysterious fluid" burned such a hole in the investor's pocket in 1882 that it is no wonder progress has been retarded.

An Electric Mountain Railway.—A correspondent of the *Daily News* in Lucerne calls attention to the electric mountain railway—the first of its kind—which has recently been opened to the public at Burgenstock, near Lucerne, under the superintendence of Mr. Abt, the Swiss electrical engineer. A bed has been cut for the most

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part out of the solid rock in the mountain side, from the shore of the Lake of Lucerne to the height of the Burgenstock — 1,330ft. above its level, and 2,860ft. above the level of the sea. The total length of the line is 938 metres, and after the first 400 metres a gradient of 58 per cent. is maintained for the rest of the journey. A single pair of rails is used throughout, with the exception of a few yards at half distance to permit the two cars to pass, although only one car is at present used. The motive power, electricity, is generated by two dynamos, each of 25 h.p., which are worked by a water-wheel of 125 h.p., erected upon the river Aar, at its mouth at Buochs, three miles away. The loss of electricity in transmission is estimated at 25 per cent. Only one man is required to manage the train, and the movement of the cars is completely under his control. One dynamo is sufficient to perform the work of hauling up and letting down the cars containing 50 or 60 persons. A finger moving along a figured disc before the man at the water-wheel enables him, by means of a millimetre screw, moving at the rate of a millimetre to every metre of the railway, to see the exact position on the line at any given moment of the journey, and he can increase or slacken speed accordingly. In addition to this advice, the cars themselves give him a signal at stated points, after leaving the stations, by ringing a bell at the machine-room. The most complete safeguards are used to prevent the cars breaking loose by means both of breaks and cog-wheels for ordinary use, and a steel anchor in case of accident, which will effectually prevent the car running backward. This interesting undertaking has been carried out at a cost of £25,000. The electric power gained at the stream by the water-wheel also lights the whole of the hotel buildings and its grounds by electricity, and when the railway is not working, another dynamo pumps up spring water 1,000ft. for use in the establishment. The prospect is almost equal to that from the Rigi, and the Burgenstock will, doubtless, henceforth claim a much greater share of attention than hitherto.

Colliery Lighting.—In the reports of Her Majesty's Inspectors of Mines, for 1887, on the subject of lighting collieries, Mr. Moore says: "The incandescent lamp is still progressing towards improvement. Lamps of this kind have been exhibited and tried, but they have not, so far, been adopted in any colliery here. If a practical lamp of this kind could be got, suitable for all mines, whether fiery or not, it would greatly minimise the accidents from fire-damp, because there would be no inducement to use, in any circumstance, any other lamp than a safety lamp, and small explosions would cease." Mr. Hall says: "A great change has taken place during the last two or three years with respect to the kinds of safety lamps used in mines. The old-fashioned Davy has been almost universally discarded, and lamps of a new type introduced, these latter being largely constructed of glass so as to obtain a better light, such as the Mueseler and Marsaut lamps, and are so shielded as to withstand high currents, but many practical men, more especially managers who have raised themselves from the ranks, hold the opinion very strongly that the increased use of glass without a protecting gauze in the new lamps will eventually prove a greater danger through accidental breakages than the danger that existed where unprotected Davys were in use, of the flame being passed through the gauze in high currents. This change, which is now imperative under the Act of 1887, has not been adopted with any great amount of confidence as to any beneficial result, because the best lamps in the market even now are far from ensuring any high degree of security. Electric lighting has made substantial progress, and at two or three mines here installations of fixed lights on the surface and for a short distance along the main roads underground have been in operation for some time, and prove to be an effective and economical means of lighting where existing boiler and engine power can be utilised. No attempt has yet been made in this district to supply the miners with a portable electric lamp in place of the ordinary oil lamp, but several such lamps have been submitted to scientific societies, and I believe some hundreds are already in use in South Wales. Some of these lamps approach very near to what is needed. The introduction of a strong and reliable portable electric lamp would be welcomed, and its introduction would be the means of mining operations being conducted with much greater safety. The disadvantage of electric lamps is that they do not warn as well as protect. The motto of the old Davy used to be '*Moneo et Munio*,' whereas the electric lamp gives no sign of the character of the atmosphere it may be placed in, except by means of rather elaborate addition which could hardly be used by ordinary miners, but, even granting this drawback, I believe that their general use would be a great blessing, because the light within the lamp (burning in a vacuum) can be so securely isolated and protected that there would be little or no danger of the surrounding glass being accidently fractured."

Stronger Electric Ship Lights.—The following valuable letter has been addressed by Mr. J. Kenward, Birmingham, to the editor of the *Times*, calling attention to the necessity for stronger signal lights on shipboard, and some adjustment so that the penetrative power of the coloured lights at a distance shall be equal to that of the white. The question is well worth the attention of our ship electrical engineers, as a considerable amount of business may result to those who are best able to give practical attention to the matter. The letter is dated August 24, as follows: "Your correspondent, Sir Bradford Leslie, has done well to call attention to the subject of ship signal lights. It may be affirmed with absolute truth that the chances of safety of ships at sea with regard to collisions in the night are to a large extent in proportion to the power of the signal lights they carry. Most of the lamentable collisions of the past ten years are eloquent on this point. Unfortunately, the question asked in the Admiralty Courts and discussed in the press is simply: "Were the lights burning brightly (as seen by the crew that displayed them on each vessel)?" Not, rather, "What sort of lights were burning, and what was their penetrating power in average weather?" The whole question, indeed, is one of intensity in the first place, and of equality of intensity in the second place. White, red, and green are well-chosen distinctions for governing the evolutions of a vessel under steam, and I do not think that any arrangement of white lights alone would succeed. But it is surely obvious that in a triangular signal thus composed the three members of it should be visible at the same moment in nearly all conditions, whenever the lesser elevation of the side lights permitted. In no vessel afloat is this at present the case. In the majority of our vessels the lights have three essential defects: (1) The lenses are not of the best

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optical character; (2) the oil flames are not the brightest; (3) the red and green beams are emitted from flames of equal power, with no adjustment in regard to the white. The loss of light through the best red glass is from 55 to 65 per cent.; that through the green from 70 to 85 per cent. This is a constant with all ship lights; but when a feeble flame and an ill-formed lens are employed, of course, the bad effect is enhanced. I have long, therefore, advocated the use of lenses of true optical character, and with flames so differently proportioned in the port and starboard lights that full equality with the mast light be attained. The most convenient way of effecting this is to introduce an electric incandescent lamp of, say, 200 candles into the green light, and another of, say, 100 candles into the red light. Then the emerging beams from the three would be nearly equal, and nearly equally visible at the same time. If better lenses were used, the distance also would be much increased. The statutory range is now five miles for the white and two and a half miles for the coloured lights. Little more, certainly, is ever attained with the red, much less with the green, and what this means in the case of vessels approaching each other at a combined speed of 30 miles, as your correspondent justly says, may be well conceived. It is, in fact, impossible to shape a course in time to avoid disaster, if disaster be impending. But with a concurrent range of at least six or seven miles for all the lights in clear weather, and some degree of visibility in weather when the old lights are invisible, a valuable security is gained, and a passenger may with confidence sleep through the night while the good ship is being driven at full speed on her way. The time will, I believe, come when that line of steamers will be preferred which is known to carry the most powerful and equally powerful signal lights. One company, at least, of high distinction is now preparing to give the new plan a trial, and the result may well prove that it is by no default of science that the imperfections of ship lights, with all the calamities they entail, have been so long endured."

Cowpen.—The temerity displayed by the Local Board at Cowpen in advertising for electric light tenders has called down the wrath of the *Blyth Examiner*. Cowpen is a portion only of the town of Blyth, and the *Examiner*, in drawing up a tabulated statement of the towns already furnished with the light, compares the position of Cowpen with them. "There are only (omitting from consideration London, which in spots, here and there, shows a little electric lighting) *twenty* places in which the public authorities have taken up this question? And these are not all *lighted;* some of them have only opened negotiations with electric companies, or perhaps it would be more correct to say the companies have only opened negotiations with the towns. So that perhaps not more than ten or fifteen towns are even experimentally lighted as yet. Of the above twenty, at least nine are fashionable watering-places, and there can be no doubt there is a rivalry among those places to keep up their attractiveness, and for that purpose money is lavishly and recklessly spent. Those nine places are Bath, Blackpool, Brighton, Cheltenham, Eastbourne, Hastings, Ilfracombe, Leamington, and Weston-super-Mare. The other eleven places are either cities, or very important towns worthy to be ranked as cities, if only on account of their wealth, and to whom an expenditure by way of electrical experiments comes only as a mere flea-bite. These towns are Barnet, Bradford, Dewsbury, Dublin, Edinburgh, Exeter, Glasgow, Leeds, Southampton, Taunton, and Waterford; and now we have to add that the Local Board for the district of Cowpen is nibbling at the flashing bait. Six of the authorities who are intermeddling with the electric light themselves own the gas undertakings, and may at once be taken out of the category of corporations who are actively opposed to the gas companies now existing; so that this list of twenty is thus reduced to fourteen. Out of this fourteen eight are rival and competing watering-places, spending money lavishly in the effort to keep their attractions to the fore; thus leaving throughout Great Britain and Ireland only six public authorities who on apparently ordinary grounds are introducing electricity for public lighting as a rival to gas now supplied by private companies. These are Barnet, Dublin, Exeter, Southampton, Taunton, and Waterford. Two of these are in Ireland, leaving only four for the other parts of the kingdom, and these are in England. There are also in the entire list of twenty only three Local Boards that have had the temerity to pledge the funds of their ratepayers to such purely speculative whims; the rest are municipalities of immense wealth, who can afford to run small experiments in favourite localities in their cities or boroughs—just as Blyth puts two Bray lamps in an important thoroughfare like Bridge-street. It certainly seems somewhat ridiculous that an unimportant place like Cowpen—part only of the town of Blyth—should place itself alongside of Barnet, Exeter, Southampton, and Taunton, and actually presume to teach all grades of corporations their duty as to electric lighting. If any electric lighting company contemplating tendering for the lighting of Cowpen district will first make a study of the facts and figures we have adduced, they will know more about the prospects of ultimate success with their speculation than they are likely to do from twenty interviews with that wonderful individual the 'surveyor to the board.'" And Cowpen, it adds, is the only town that thinks of entirely doing without gas, and prophecies its complete awakening in a fool's paradise. All this is very well on the part of the *Examiner*, and certainly shows an extended power of review on its part. But why not go a little further afield. If lamenting the absence of progress in England of electrical enterprises, large or small, as being to due Chamberlain's Act, why not ask what is done in countries unhampered by such an Act, as is now for the first time the position in England? Look at America for instances, where every little town of 5,000 inhabitants has its electric lighting plant, more often without gas than with it. Or if America is too far away, then France will give instances enough, and those rapidly extending, of little country towns, such as Mousson, where a double line of wire strung on neat poles all round the town carries lights driven by a water-wheel from the small waterfall at the town. Switzerland, Austria, and Italy furnish instances in considerable number of small electric lighting plants perfectly successfully undertaken, driven by steam as well as by water. The good people of Blyth and Cowpen may rest assured that if they go to the proper quarters they can ascertain exactly what *can* be done, can be referred to sufficient instances of what *has* been done, and may, if the conditions thus plainly enough stated satisfy them and their requirements, themselves become one of the first instances of what *will* be done in the electric lighting of small towns in England.

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THE MAGNETIC FIELD.—II.

We have now touched upon the principal characteristics of lines of force, or, as we shall in future call them, "magnetic stream-lines," and we recapitulate the properties of our mechanical model representing a magnetic field as follows:—

The space within which the field exists is filled with a fluid in motion. The direction of flow in any point is indicated by stream-lines, along which a free magnet-pole is urged in the same manner as a material body would be urged by friction or impact. The force exerted upon that body is directly proportional to the absolute velocity of flow. The particles composing the fluid have inertia, but only in the direction of flow, and are not subject to the influence of centrifugal force. The particles attract each other in the direction of the stream-lines, but neighbouring stream-lines repel each other. The velocity of flow along any particular stream-line represents the force with which a unit-pole placed on that line would be urged on. This force may vary from point to point on the same stream-line. All the stream-lines are closed curves, whether they pass wholly through air or other non-magnetic substance, or partly through non-magnetic and partly through magnetic, or wholly through magnetic substances. The last-named property, although it cannot be directly proved by experiment, owing to the impossibility of placing an exploring-pole into the field where that is entirely enclosed in metal, is indeed self-evident from the consideration of the fact that the velocity of a column of fluid which has inertia cannot undergo sudden changes. If any stream-line were not closed on itself, the velocity of the fluid at its two ends would be zero, whilst immediately within these points it would be a definite quantity. This is physically impossible, as there must be a continuous supply of fluid at one end, and a continuous discharge at the other. The stream of magnetic matter must, in fact, behave very much like a stream of water kept whirling round by paddles or other contrivances in a circular trough. The width of the trough may vary from point to point, but the total quantity of water passing through successive cross-sections of the trough must be the same. The analogy goes even further; just as the moving water in our circular trough represents a certain amount of mechanical work, so does the stream of magnetic fluid require the expenditure of mechanical work in order to be started, and is capable of yielding up this work upon being stopped again. In other words, every magnetic field has inertia. Reasoning from analogy with the circular trough filled with water, we can make an estimate of the amount of inertia represented by a magnetic field. To simplify matters, we will assume that the trough has the same area throughout its circumference; the velocity of the water will then be the same all round, and the total inertia contained in the whirling ring of water will be proportional to the total mass of water contained in the trough and to the square of its velocity. Similarly, we should expect to find that the total inertia of a uniform circular magnetic field is proportional to the total mass of the magnetic fluid in motion—that is, the volume of the field, or more precisely, the volume of the ring of iron within which the stream-lines are supposed to flow—and to the square of the velocity of flow—that is, the square of the induction per unit area. We shall later on investigate this important problem regarding the inertia of a magnetic field more in detail, and then we shall find that the relation here merely foreshadowed by analogy with hydrodynamics is indeed correct. For the present, however, we need not make an actual determination of the energy of a field; before doing that it is necessary to show in a general way how this energy can become apparent in the shape of electrical energy, and to do this we shall endeavour to represent the interaction between a current and a magnetic field by means of a mechanical model.

Let the surface of the paper be pierced at right angles by a straight wire A, (Fig. 1), and sprinkle iron filings around the wire These will arrange themselves in the manner indicated in the sketch. Near the wire the filings lie more densely and further away from it they appear to be more thinly arranged. The stream-lines are in this case all circles concentric with the wire—that is to say, the magnetic fluid forms a whirl round the wire just as in a circular tank a whirl of water may be produced by revolving in it a central shaft provided with paddles, or by pushing a screw surface, say the propeller of a ship, vertically through the water. As the propeller descends in the middle of a tank, whilst itself prevented from rotating, its blades will produce a rotating motion or whirl in the water. If the diameter of the propeller is considerably smaller than that of the tank, the circumferential velocity of the water will be less at the outer periphery of the tank than nearer the centre, where the water is under the immediate influence of the propeller blades, and this will in a crude way represent the diminution in the velocity of the magnetic stream lines as we go farther away from the wire. We say in a crude way, because the change of speed in the mechanical model is necessarily somewhat abrupt, whereas in the actual field it is perfectly gradual. It has already been mentioned that a magnetic pole has a tendency to move along the stream-lines just as a solid body is urged along in the direction of the current when immersed in a fluid in motion. It might now be asked, "How is it that the iron filings sprinkled on the paper do not rotate around the wire?" Experiment does not reveal any tendency to such motion. All we observe is a tendency in the filings to crowd up to the wire; but beyond this movement, which is at right angles to the longitudinal axis of each particle, there is no movement in the direction of this axis itself. This absence of movement can only be explained on the assumption that whilst one end of the little piece of iron is impelled in one direction, the other end is impelled in the opposite direction,

FIG. 1.

that, in fact, there are two opposite and equal forces at work which can turn the piece of iron on an axis like a compass needle, but cannot move it bodily. We are thus compelled to assume the existence of two magnetic currents flowing within the same space but in opposite directions, one current acting upon the north and the other upon the south pole. We use the term north pole to indicate that pole of a compass needle which points to the geographical North. When speaking of the direction of lines of force it is customary to confine the term to those lines along which a free north pole tends to travel, corresponding in our new conception to the positive current of magnetic matter. A south pole would then be similarly affected by the opposite or negative current of magnetic matter. It is, however, not necessary to deal with both currents. We may disregard the negative current entirely, provided we bear in mind that the effect produced at the south pole of a magnet is always equal and opposite to that produced at its north pole. By confining our investigation to the positive current of magnetic matter (in the same way as we only speak of one current of electricity, although we should in reality speak of a positive and negative current which flow in opposite directions) we shall simplify the treatment without sacrificing scientific accuracy.

Returning now to our mechanical model of the field produced by an electric current flowing along a straight wire. We have represented this by the whirl of water in a circular tank set up by advancing a screw propeller along the vertical axis of the tank. The same effect might also be produced by a paddle-wheel, the boss of which is supported in collar bearings, and has a screw thread cut on the inside. Let the shaft of this paddle-wheel be a screw to fit the boss, and let the whole apparatus move frictionless. Upon thrusting the screw through the boss the wheel will

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be set into rotation, and will impart rotary motion to the water. In this model the screw shaft represents the wire, the force we apply in thrusting the screw through its nut represents the E.M.F. applied, and the speed of advance represents the current, the moving water takes the place of the magnetic field, and the paddle-wheel is the connecting link between cause and effect. What the real nature of this connecting link is we shall not stop to inquire. It is at present beyond human ken, and will in all probability remain as much a mystery as the secret of gravitation and other natural phenomena, which are vaguely classified under the title "action at a distance." If we knew the mechanism by which these actions are produced there would be no need of casting about for mechanical models to represent such phenomena as we are now investigating. But as such knowledge is denied us, we must be content with more or less crude representations.

It will be convenient to arrange our model of the field surrounding a rectilinear current in a slightly different form. Instead of placing the water in an open tank, we suppose it contained in a cylindrical box, B (Fig. 2), and place the box with its axis horizontal so as to eliminate the weight of the shaft. Let a keyway be cut in the shaft to prevent it from turning by means of a feather, F, fixed in space, and let it be thrust through the boss of the wheel by means of a pull applied by a weighted cord going over a pulley, P. Let there be some friction in the pulley, which increases directly with the speed of its rotation. Now, if we place a certain weight, W, upon the pan, the shaft will slowly begin to advance to the right and gradually gather speed as the inertia of the water is being overcome by the paddles, A; but the increase of speed will not go on indefinitely; it

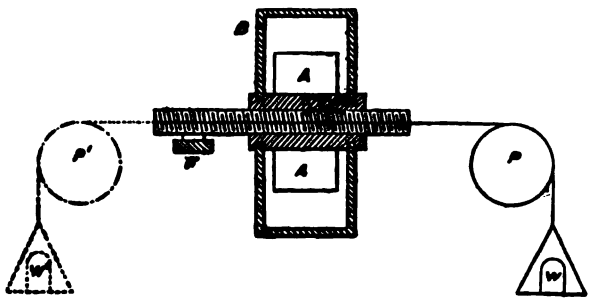

FIG. 2.

will only go on until the friction of the pulley has become equal to the weight. After this point has been reached, the speed of advance of the shaft remains constant. It is useful to observe that the final—that is, the maximum—speed attainable with any given arrangement is independent of the quantity of water contained in the box, and depends only on the weight in the pan and the coefficient of friction with reference to the speed. The mechanical process here explained at some length is an exact counterpart of the phenomena observable when a current is sent through a wire. Instead of the weight we have the E.M.F. of the battery or dynamo; instead of the friction of the pulley we have the resistance of the circuit, and the speed of advance of the shaft represents the current. The weight in descending has given out energy; a certain portion of this energy has been used up in overcoming the friction of the pulley, and is therefore lost. The remainder of the energy has been used up in imparting motion to the water, and as we have assumed that our hydraulic apparatus works without frictional or other losses, the whole of this energy must be considered as simply stored in moving water and as recoverable. Suppose, then, that after we have allowed the weight to act a sufficient time to produce the maximum or final velocity, we suddenly remove the weight. What will happen? Clearly the water will continue to revolve, and the shaft will continue to advance with the same speed as before the removal of the weight. If the advance of the shaft is not retarded by some opposing force, the energy stored in the system remains unaltered. Now suppose we take the cord off the right-hand end of the shaft and attach it to the left-hand end, taking it over the pulley, P′, which we assume to have the same coefficient of friction as the other pulley. The pulley, P′, will now be set into rotation by the cord, and its frictional resistance will cause a certain tension in the horizontal part of the cord, producing a pull to the left on the shaft. This will tend to retard the motion of the shaft to the right, and, consequently, also the rotary motion of the paddle-wheel. The water will now overtake the paddles and exert a pressure on their surface, which by means of the screw will be transformed into a push on the shaft directed to the right. In this way the energy in the water will gradually become exhausted, and motion will cease. The whole of the energy has in this case been absorbed by the friction of the pulley—in other words, has been transformed into heat. Suppose now that we had put a weight, W, upon the pan on the left. This weight would have been raised to a certain height before the water in the box could be brought to rest, and the energy contained in the water would in this case have been used up partly in the production of heat as before, and partly in raising the weight. Now, let us suppose that we put an excessive weight on the left pan, or that we suddenly clamp the spindle of the pulley, P, tight in its bearings, so as to prevent it from turning. This is equivalent to increasing the coefficient of friction to infinity. What will happen? The cord will stretch and finally break, and we can imagine the nature of its material to be such that the whole energy contained in the water becomes used up in producing the rupture.

(*To be continued.*)

LEAVES FROM THE DIARY OF A YOUNG ELECTRICIAN.

BY BROAD BENT.

(*Continued from page 162.*)

April 29.—A new engine-driver starts to-night. I had to get rid of the last because he knew too much—that is, he would not be told anything. The new man brings very good testimonials from previous employers, so perhaps he will be better.

One of the commutators is sparking fearfully to-night, and the brushes are so hot that they cannot be touched with the bare hand. The sparking is not the fault of the brushes, for I have just filed them all up and they are pressing very firmly on the commutator. We have only three more hours to run, so I will have a look at the commutator when we stop.

April 30.—Last night, when we stopped, I found that two of the segments of the commutator had worn quite flat, and a few of the adjacent ones were very much "pitted" with the flashing. The ends of the brushes, too, showed signs of the high temperature to which they had risen, many of the wires being fused at the ends into little balls of copper. The cause of the flat place was probably owing to the two copper bars not being so hard as the others, which would cause them to wear more rapidly. Having worn down a little, the brushes would jump each time the flat place passed them and spark. The heat of the spark would probably soften the surface of the bars still more, and so augment the evil. With a very smooth file I reduced four of the adjacent segments a little—that is, two on each side—then filed and emery-papered the whole until the surface was tolerably smooth. I then "set" the brushes, screwing them very firmly down on the commutator, but allowing at the same time sufficient spring to prevent them jumping over the "flat."

May 2.— The commutators are running sparklessly now; it would be impossible to tell that any current was passing. Several times to-night the lights have flickered; not an ordinary slight flicker, but they have gone down almost black. I can't make it out. It is said that incandescent lamps have a longer life with alternating currents than with direct, so I intend to reverse the dynamos every week, commencing to-night.

May 3.—I tried to reverse the dynamos last night, but did not succeed. I tried first by changing the terminals of the shunt wire, and "thereby hangs a tale," as Grumio would say. On disconnecting the shunt wire I found it was broken inside the insulation, a few inches from the

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end. This undoubtedly was the cause of the lights flickering occasionally, but how the wire became broken "deponent sayeth not." When the two ends were in contact the current would pass, and the field-magnets be excited. Any extra vibration, perhaps that caused by a passing train, would separate them for an instant, thus interrupting the current, and allowing the field-magnet cores to become almost demagnetised, short-circuiting the other dynamo through the armature. Before complete demagnetisation could occur the spark of self-induction would probably fuse the two ends of the broken wire together, and the lights would go up again. All this would happen in a few seconds.

However, to solder these ends and cover up the joint was a matter of only a few minutes, and the reversing process was once more attempted. Having reversed the connections of the magnets, I told the driver to turn on the steam and run the engine for a short time. "Faster, faster," I shouted, "put on full speed." "It's faster now, sir, than we generally run," the man replied. Well, that's a strange thing, I thought, running full speed, brushes down, magnets connected up, and yet no current. "Stop her; we'll try some other way." I then altered the magnet connections to their first position and reversed those of the armature, but with the same result, "nary a light." "What a fool I must be!" I suddenly exclaimed, after considering a little while. "How on earth could those dynamos excite themselves?" I was glad no one was there to see what an ass I had been making of myself (of course the driver did not know what I was up to). I ought to have driven one dynamo as usual, and excited the other from it, but it was too late then, so I did what I might have done in the first place—*reversed the leads.*

May 4.—The engine-driver gave me a little of his history last night. From his own story he has had some rough times. His last job was out on the West Coast of Africa, where he had attacks of sunstroke and malaria fever, so he had to be sent home to the hospital. He may be all right, but men who have had sunstroke sometimes have slight attacks of madness. I hope he won't start any mad freaks here.

May 5.—I had an awfully lively time last night. The new engine-driver, after talking in a rather vague manner, went out to get "a half o' old six." It took him about three hours to get it. I thought he was never coming back. When he at length did return, I heartily wished I had never seen him, for the combined effects of the sunstroke, fever, and half-pint had made him *mad.* At first he wanted to fight. Well, I didn't; so he said he would put me in the fire-box if I did not stand up and put up my "maulers." I thought "discretion was the better part of valour," so tried to laugh it off, as though I thought he was joking. This succeeded for a time; but presently he began again. "I'm tired of life," he remarked; "aren't you?" "Well, not exactly," I replied; "but what's on?" "You'll see in a minute, boss," he remarked; "I'm just going to 'bust' this 'ere boiler!" So saying, he flung open the furnace doors, and then threw on shovelful after shovelful, till the fire-boxes were full up to the doors. He then pulled up the damper, and soon the fires were roaring. In a short time the steam was "blowing off" at the safety-valve, so this mad idiot went and sat on it. I immediately tried to close the damper, but my friend the madman threatened to fling a spanner at my head if I went near it. As might be expected, I was in an awful funk; was I to stop here and get blown up, or quit my post of duty and save myself? I was not long deciding, for the heat and the effects of the "half-pint"—which was probably not much short of half-a-gallon—made this unpleasant companion sleepy. So he left his position on the valve, and soon fell asleep on a bag of waste. I got on all right without him till "shutting-down" time, when he was still asleep. This morning he remembered nothing at all about the occurrence, but I must find some excuse for giving him the sack, as this sort of thing is unpleasant, to say the least of it.

May 8.—There is a signal-box just outside the "shed," which is in telegraphic communication with all the stations. When anything is wanted on any of the stations, the signal man sends "E L" (electric light) on the through instrument. They don't have occasion to send often, as we travel round frequently. The usual message is "Send the electric light man here at once." "The electric light man" (which means the machine man in charge at the time) then leaves whatever he is doing and rushes off with a pair of pliers, a screw-driver, a pocket knife, a few feet of wire, and one or two lamps, to find generally that there is one lamp out, owing to bad contact on the loops, which the least touch puts right again. If he happens to have been called away from dinner to attend so small a matter, he soliloquises on sanguinary matters, fools, thunder and lightning, &c.

The signal-box boy has just come in to say I am wanted at S.M. *at once; 5 lights out.* Now, I wonder what tools I want. Better take all the lot, to make sure.

(To be continued.)

ELECTROLYSIS OF SEWAGE.

The introduction of the use of the dynamo in any direction is interesting to all makers, but if it should prove useful in sewage purification a very large trade would be opened up. Mr. William Webster is the apostle of electrolytic treatment of sewage, and in the following notes of a paper, read before the Sanitary Engineers, he gives detailed information about his experiments. He says:

"It is quite ten years since I carried out my first experiments in electrolysis, but in those days the available electric apparatus had not attained such completeness as we now have it. I first of all wish to remove an impression which, I have been given to understand, is lurking in some minds—that it is impossible to electrically decompose pure water. Water is easily decomposed provided the current of electricity is of such intensity that it can overcome the resistance. Nicholson Carlisle decomposed water in the year 1800; the decomposing effects produced are precisely in accordance with the chemical equivalents of the substances electrolysed; for instance — the same amount of electricity that would reduce 56 parts of iron from its solution would reduce 207 parts of lead, or 16 parts of oxygen, &c. This is practically the explanation of the whole system; for the chemical changes which take place in sewage when it is electrolysed, depend chiefly on the well-known facts that water and sodium, magnesium and other chlorides (which are always present in sewage) are split up into their constituent parts. Thus, we have at the positive pole chlorine and oxygen set free, and these elements are liberated in a nascent state, a condition in which they are intensely active, so that the organic matter in the sewage is rapidly oxydised and burnt up to inocuous compounds. So rapid is this action, that I will now act on a little Crossness sewage, and produce a disinfecting liquid, which is nothing more or less than hypo-chlorous acid—the strongest oxydising agent that is known. To obtain this quickly, I must separate the positive action from the negative by a porous diaphragm. At the negative pole I obtain ammonia, potass, soda, magnesia, &c. So strong is the action of oxide of chlorine, that I have found no pressed carbon plates would stand its action; I am therefore compelled to use cut carbon or coke.

"It was this fact that made me investigate the cost, and the result was, knowing that iron salts were of great use in precipitating organic matter in solution, that I experimented with iron electrodes, for the oxydising acids produced by this action being probably 100 times more active than any acids produced by chemical processes alone, it necessarily followed that the iron salt produced must have similar properties. The nascent chlorine and oxygen generated partly unite, and, with the water, form hypo-chlorous acid; the positive iron plate being attacked and ferrous hypo-chlorite formed; but a portion of the hypo-chlorous acid attacks the organic matter, for it is well known that putrifying sewage has a strong affinity for oxygen.

"To still further strengthen this action, I have lumps of carbon cast into the iron plates, thus securing a supply of the before-mentioned acid.

"The iron plates are common casts run direct from the furnace into this form instead of pigs, and are used for the

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TABLE A.—Parts per 100,000.

Date of Experiment.	Appearance.	Odour.	Nitrogen as			Chlorine as Chlorides.	Oxygen required to oxydise organic matter.	Total Solid Matter in Solution.	Loss on incineration of total Solids.	Suspended Matters.			
			Free Ammonia	Albumenoid matter.	Nitrites and Nitrates.					Total.	Mineral.	Organic.	Ferric Oxide. Fe_2O_3.
1888.													
Mar. 26.	Raw sewage, very turbid and opalescent	Bad	2·59	0·47	None ...	9·74	1·95	61·72	12·57	65·28	39·47	25·79	7·09
	Effluent, clear	None ...	2·30	0·30	None ...	9·19	1·07	57·43	9·14	None ...	...	...	...
April 20.	Raw sewage, very turbid and opalescent	Slight ...	1·88	0·19	Trace ...	5·27	1·17	42·43	7·90	47·31	33·01	14·30	6·13
	Effluent, clear	None ...	1·63	0·14	0·029	4·67	0·53	38·60	4·10	2·01	1·74	0·27	1·69
April 27.	Raw sewage, very turbid and opalescent	Slight ...	2·65	0·42	None ...	16·43	1·24	41·95	5·86	Not estimated.			
	Effluent, clear	None ...	2·28	0·18	0·017	13·79	0·52	37·40	2·85	None ...	...	...	...

positive poles, the negative plates being thin rolled sheet. The positive plates are gradually acted on by the acids produced, but the negative plates are not acted on, and will remain in the same condition for years. This is so well known that I need not enlarge upon it. I have estimated that the waste of iron at the positive pole is about one grain per gallon, but of course this entirely depends upon the electric current used. The hypo-chlorite of iron formed at the positive pole is acted on by the free ammonia, sodium, potassium, and magnesium hydrates and the ferrous hydrated oxide precipitated. This particular oxide of iron has the property of combining with organic matter, and it is a peculiarity of this salt to take a white hue, and then by exposure to the atmosphere to become green, and ultimately an ochrey red colour.

"This action can be seen almost daily in any dye-house during the dyeing of buffs. The cotton goods (representing organic matter) are dipped into an iron solution, and then passed through an alkaline bath. The shade is green, but slight exposure to the air produces the buff colour, the oxide of iron being precipitated within the fibres of the cotton. The ferrous hydrated or protoxide of iron is so beautifully precipitated, one may say, in its most active condition by this electrolytic process, that it takes up more organic matter than if precipitated chemically; for by chemical precipitation the iron oxide carries a large part of the suspended matter in the sewage with it, but only traces of the dissolved organic matter. In the electrical process, the whole of the matter suspended is carried with the oxide of iron, together with a considerable portion of the organic matter in solution, and, if necessary, the whole of the soluble organic matter can be oxydised. The precipitate itself is carried to the surface by the numerous bubbles of hydrogen issuing from the negative pole, and the effluent may be run off quite clear from below, or may be run with the precipitate into settling tanks, where the deposit will take place in from half an hour to two hours; the precipitate being exceedingly flocculent, subsides readily. The sludge formed does not hold so much water as by chemical process, and presses without any addition of lime. The effluent is less alkaline than the natural sewage, and, if necessary, can be rendered neutral by passing through coke filters arranged in such a way that the electric current can be applied, thus further purifying the effluent and delivering it in such a state that, personally, I should have no objection in drinking it. The reason of the alkalinity being reduced is that a small quantity of free ammonia is carried off with the hydrogen gas at the negative pole, and also by the formation of hypo-chlorous acid. It is by means of this coke filter that potable water can be purified either on a large or small scale, and the treated sewage is not liable to secondary fermentation, nor does it form a precipitate when mixed with ordinary river water. The chlorides are slightly diminished in quantity owing to the escape of nacsent chlorine at the positive pole. The amount of soluble mineral matter is not increased in quantity as in ordinary precipitating processes.

"The chloride of lime of commerce is really hypo-chlorite of lime. It has been suggested that the hypo-chlorous acid may possibly be as objectionable in its after effects as the salts of lime, but this is not the case, as hypo-chlorous acid is an unstable compound, which, having delivered up its oxygen in oxidising organic matter, changes into hydrochloric acid, which neutralises the alkalinity of the sewage.

"As I have already demonstrated that hypo-chlorous acid can be obtained in quantities by means of a porous cell enclosing positive pole, so likewise, by enclosing the negative pole, a solution of ammonia, &c., can be obtained from the raw sewage.

"I have brought with me a weak solution of the disinfecting fluid obtained from sewage twelve months ago; also a sample of an effluent eight months old. I have shown that the sewage can be purified to any extent, even to conversion into a disinfectant. It therefore only remains for me to enter into the question of cost, which I will do as briefly as possible, and it is just as well to mention that this will be partly ruled by the particular state of purity you require your effluent.

The chief expense is the engine-power. My experience up to the present time is limited to treatment of about 100 gallons of sewage at any one time; and from a large number of experiments, I found it would be possible to treat this quantity with about ½ h.p. The dynamo and engine were unsuitable for my experiments, as the dynamo was only fit for electric lighting, and the engine 25 years old—without a governor. I should, therefore, prefer to think the h.p. over-estimated. The time occupied in treating every 100 gallons varied from five to ten minutes. The consumption of iron was one grain per gallon. The cost of this is easily estimated when one knows the market price of pig iron. By kind permission of the Metropolitan Board of Works, I have erected works at my own expense at the Crossness Outfall of sufficient capacity to treat sewage at the rate of one million gallons per diem. As I have sufficient confidence in this process to risk the large outlay entailed. For this I have had an Edison-Hopkinson dynamo specially constructed, giving an output of 1,600 amperes and 20 volts.

"Unfortunately the electrical portion of the works is not yet completed, or I should have hoped to have had the pleasure of inviting you to inspect them.

"The question of cost resolves itself into this: The more iron plates you introduce into the system, the greater the surface, and the lower the resistance, consequently the less H.P. required. The increase of the iron plates is only an increase of prime cost, and does not mean a greater waste of iron; this means a saving of labour as the more iron originally used the less frequently would require renewal.

"I hope to prove that by using positive plates 1in. thick their duration will be from five to ten years. If the proportion of ½ h.p. to 100 gallons in 10 minutes holds good, as I am inclined to think it will, then 25 actual h.p. would be capable of purifying 1,080,000 gallons of sewage in 24 hours. I should much have liked to have gone into more minute details connected with these experimental tests, but until I have verified the present results on a practical working scale, I feel it would be premature to quote figures."

The results of a few analyses of sewage before and after treatment are given in Table A. (*See* above.)

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

ESTIMATING.

There is a complaint heard from all quarters that profits are too low, because of the tendency of weak firms to lower prices to starvation point in order to obtain a semblance of work. It is well known that tenders have been sent in for various works during this year of grace at so low a price that other tenderers have wondered how it was done. The same system has been pursued in other industries, with the result that sooner or later the weak firms went to the wall and prices stiffened. Sometimes "rings" have been formed to regulate prices, and in certain cases with a considerable amount of success. It is not so very many years ago that the steel industry was dominated by such a ring. For a time again tube makers acted together in harmony. We should hardly care to suggest any such attempt to regulate prices with regard to electrical apparatus, because any such suggestion would savour of the ridiculous rather than the practical. The same conditions do not hold in this trade as held with regard to steel rails, or with tubes, but we can do no harm in suggesting caution to reckless traders. In not a few instances that have come under notice the errors have evidently arisen through ignorance, and it is with a view of pointing out this weakness very clearly to those who have in some way the power to overcome it that we venture to make these remarks. A short time ago we recorded a very pleasant evening when Messrs. Crompton met their old and present pupils at dinner at the Holborn Restaurant. Among the speeches made was one by Mr. Albright, who dwelt specially upon the fact that part of the training consisted in "learning to estimate." Now, with the exception of men trained in some such practical establishment as this, we venture to say that few of those who enter the profession ever had the subject of estimating presented to them in any shape or form. A large number of men have received their training at special schools, such as those at Princes-street or London Bridge, or at the City and Guilds Institute, or at the colleges at Bristol, Liverpool, Nottingham, Dundee, Aberdeen, Glasgow, &c., but has one single man from any of these educational establishments ever spent an hour in getting out a practical estimate in connection with a given specification? When he enters into business, as he frequently does with little or no other than the training thus received, he has to prepare estimates, and he may do so in two ways—correctly or incorrectly. If the estimate is prepared incorrectly it may be too low or it may be too high, and it may be politic to say in either case a loss is sustained. The work being estimated for at too low a figure, is obtained, and a direct loss results; estimated at too high a figure, profits that might have figured in the firm's books do not appear, for the work is given elsewhere, and so a loss is sustained, if that can be

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called a loss that was never in one's possession. "Quantities" is a familiar word with builders and architects, and the former base their estimates upon the quantities taken out under any design of the latter; but quantities are as important to electrical contractors as to builders, and should be as carefully considered by the one as by the other. There are plenty of surveyors who make a speciality of taking out quantities for builders; but we doubt if, outside half-a-dozen well-known firms, electrical quantities are ever taken out with any degree of accuracy, and hence the estimates founded upon inaccurate quantities must be many. We recently heard of a firm—not an electrical one—where the partners could not understand why the bank balance was so bad. It was thought and maintained by one of the partners that a gross profit of 60 per cent. was being made, and as the business was very large the net profits should have been considerable. When a thorough investigation was made by the accountants the gross profits were found to be about 40 per cent., a difference of 20 per cent. through mistaken calculations, and it is easy to understand that the net profits had vanished. Here an expected balance to the good of about £5,000 became really a balance to the bad of about £500. So far as the ordinary small installations are concerned, there should not be much room for difference in prices, and yet the outsider would be astonished to see the great difference that really exists in tenders. The tendency of the man ignorant of the true method of estimating, is towards too low a price. He lumps items that should be calculated separately, and, by rule of thumb, dashes at items that are foreign to his experience. The working man, too, is expected to do an ideal day's work—one that may conscientiously be performed in the millenium, but not now; he reckons upon purchasing materials in units at the same price as they are quoted per gross, altogether believing he is approximately correct, and has allowed a 20 per cent. net profit. Happy is the man who starts in business knowing his weakness. A careful consideration of the whole matter will show that the plan explained by Mr. Albright is of the greatest value to those who subsequently become principals in business, or on the estimating staff in large establishments. Imitation being the sincerest form of flattery, we suggest that it is not impossible to imitate Messrs. Crompton, so far as this particular question is concerned, in some, at any rate, of the educational establishments to which we have alluded. Quite lately, critical remarks have been made about a certain specification, but, after all, a debt of gratitude is due to the author of that specification for writing it. Whatever may be the individual opinion as to its good or its bad points, there it is, a guide useful to a very large number of men who have never previously seen a specification of the kind. However, to return to the moral we have endeavoured to instil, the contention is that not only is it necessary to know how to do the work, but it is essential also to know how to charge for the work. Ignorance of the one is as vital as ignorance of the other.

CORRESPONDENCE.

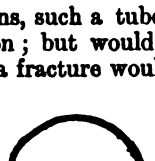
COPPER TUBES.

To the Editor of The Electrical Engineer.

Sir,—In reading the account you publish of the examination of that copper tube which burst on board the ss. "Elbe," it seemed to me that the effect of the expansion of the unaltered portion of the tube upon the part rendered more brittle by brazing would be to produce a further strain upon this latter portion, in addition to that which it was already receiving from the direct effect of the pressure and temperature of the contained steam.

For that part of the copper tube which was not deteriorated by brazing would attempt to expand naturally, while under the influence of steam pressure and heat, by virtue of its unaltered properties, while the portion which had lost these properties could not do so, and therefore would have to bear the strain due to the expansion of the adjacent metal pulling on it, in addition to such other strains as were common to the whole circumference of the tube, while the direction of this additional strain would be such as to produce or increase an internal longitudinal fracture along the line of greatest brittleness.

Under these conditions, such a tube would not be perfectly circular in section; but would have a depression at the brittle part, where a fracture would occur.



I think that such a fracture as was found would be produced upon the first occasion that full pressure steam was admitted to the pipe, and so would allow a certain amount of expansion in the neighbouring parts, and a consequent diminution of the strain due to it to take place; after which the ordinary steam pressure might be borne for some time, as the strains from inequality of expansion no longer exist.—Yours, &c., Harold G. Dixon.

Guy's Hospital, S.E., August 26th.

INSTITUTE OF MEDICAL ELECTRICITY.

To the Editor of The Electrical Engineer.

Sir,—In reply to the letter of "Alpha" in your last week's issue, I desire to point out that this institute is "established in the West-End of London," and is fitted (or, more correctly, is being fitted) with "the best apparatus" that can be obtained. Further, I would say that electromagnetism will have its full share of consideration here, and such use and recommendation as the results of experiment warrants, in common with other forms of electrical treatment which have, or claim to have, any use for curative purposes.

If "Alpha" will kindly let me know his name and address, I will gladly send him full particulars of the institute and its objects.

With regard to "Alpha's" last paragraph, and Mr. Herford's letter on the same subject, I will only say that I have received a communication direct from the latter gentleman, and that its subject-matter is under the consideration of the directors.

Perhaps you will allow me to add that, in fulfilment of the intention stated in my letter of the 17th inst., we have secured the services as physician to the institute of a medical man of excellent standing, who for some years past

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has had special experience of electro-therapeutics in one of the large London hospitals, and has now entered very earnestly into the work of the institute.—Yours, &c.,

H. NEWMAN LAURENCE, Managing Director,
The Institute of Medical Electricity, Limited,
London, S.W., 29th Aug., 1888.

SPRAGUE MOTOR CURVES.

BY FRANK P. COX, B.S.

The method used in obtaining these curves is known as Hopkinson's method.

Excepting the dimensions of the machine, only one measurement is necessary. That is to determine the value of the constant ν. This value is the ratio of the total lines of force through the field-magnets to the useful lines through the armature. I have previously described the method of finding an expression for these lines. In this case $\nu = 1{\cdot}76$.

It is also necessary to have a curve representing the relation between the magnetising force H and the permeability, μ for wrought iron, and a similar curve for cast iron.

Hopkinson gives curves for cast and for wrought iron, showing the relation between B, the magnetisation and H. From those curves several values of μ have been worked out, and the following curves constructed:

Cast iron.		Wrought iron.
μ	H	μ
400	10	1,130
270	20	700
207	30	495
168	40	384
140	50	315
121	60	268
108	70	233
98	80	208
90	90	188
84	100	170
71	125	135
61	150	117
51	200	92

The method of using this curve will be described later. We must now make use of Hopkinson's formula to find the required magnetising forces.

The formula is

$$4\pi n c = l_1 f\left(\frac{I}{A_1}\right) + 2l\frac{I}{A} + l f\left(\frac{v\,I}{A}\right) + 2 l f\left(\frac{I}{A}\right)$$

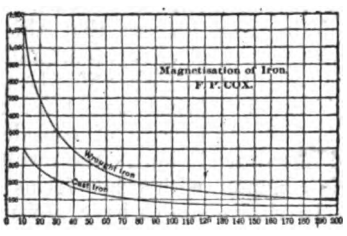
Where

"n" is the number of turns on the field,

"c" the current in C.G.S. units,

"I" represents the induction and is the quantity we wish to find the value of.

"l_1" is the length of the lines of force in the armature, and is slightly greater than the shortest distance between the pole-pieces. It is in this case 10 cm.



"A_1" is the cross-section of the iron in the armature, and is ·9 of the total cross-section in a horizontal plane; 10% being allowed for lamination. A_1 is 224 sq. cm.

"l" is the perpendicular distance between the faces of pole-pieces and the armature core. l_2 is ·7 cm.

"A_2." This is the area of the face of pole-piece, + 13%, to allow for dissipation of field. It is 286 sq. cm.

"l_3" is the length of lines of force in the field—that is, the length of the field core. It is 16·8 cm.

"A_3" is the area of the field cores, and, since there are two magnetic circuits in parallel, twice the area of one magnetic limb will have to be used. A_3 is 153·4 sq. cm.

"l_5" is the length of lines of force in pole-piece. This cannot be measured *exactly*, but is approximately 21 cm.

"A_5." As in the case of A_3, the mean area of cross-section will have to be doubled, giving 198 sq. cm.

"ν." As stated before, ν is 1·76.

The formula now becomes

$$4\pi n c = 10 f\left(\frac{I}{224}\right) + 1{\cdot}4\frac{I}{286} + 16{\cdot}8 f\left(\frac{1{\cdot}76\ I}{153{\cdot}4}\right) + 42 f\left(\frac{I}{198}\right).$$

It is now necessary to substitute for the functions their values, and to divide the equation up into its parts. The first term represents the force required for the armature, the second that for the air space, the third for the field, and the fourth for the pole-pieces. In the equations the functions may be expressed by multiplying the term by $\frac{1}{\mu}$. Now, to obtain the curve for the armature we vary the magnetising force $x = \frac{10\ I}{224\ \mu}$ and for the different assumed values of x work out the value of I. The curve is then plotted with these values of x and I. In a similar manner the curves for the other parts are constructed. The air space will in every case be in a straight line. Before discussing the characteristic curve it may be well to construct the other curves, as the characteristic is taken directly from them.

We have for the armature

$$x = \frac{10\ I}{224\ \mu} \text{ or } I = \frac{224}{10}\mu x$$

For the air space,

$$x = \frac{1{\cdot}4\ I}{286} \text{ or } I = \frac{286}{1{\cdot}4} x$$

For the field,

$$x = \frac{29{\cdot}6\ I}{153{\cdot}4\ \mu} \text{ or } I = \frac{153{\cdot}4}{29{\cdot}6}\mu x.$$

For the pole-pieces,

$$x = \frac{42\ I}{198\ \mu} \text{ or } I = \frac{198}{42}\mu x.$$

Now, when we give to x different values, the value of I for each one is easily worked out, since μ depends directly upon x, and its value can be obtained as follows: Since x represents the total magnetising force, we must divide by the length of the line of force to obtain the magnetising force per unit length. Now, having obtained this value, we look upon the magnetisation curve, which is plotted in terms of μ and magnetising forces per unit length. This curve gives us the value of μ for this value of x, and having this the value of I follows directly. The following tables give values required in the construction of the curves:

ARMATURE

$\frac{x}{l_1}$	x	μ	I
5	50	1,550	1,736,000
10	100	1,130	2,531,200
30	300	495	3,326,400
50	500	315	3,528,000
80	800	208	3,727,360
100	1,000	170	3,808,000

AIR SPACES

x	I.
1,000	204,300
2,000	408,600
3,000	312,900
4,000	817,200

FIELD.

$\frac{x}{l_3}$	x	μ	I
5·95	100	1,410	730,380
17·85	300	765	1,188,810
29·75	500	497	1,287,230
47· 6	800	328	1,359,232
59· 5	1,000	270	1,398,600
89·25	1,500	189	1,468,530
119·	2,000	143	1,481,480

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POLE-PIECES.

$\frac{x}{2l_5}$	x	μ	I
7·14	300	442	624,546
11·9	500	370	871,350
19·04	800	280	1,055,040
23·8	1,000	242	1,139,820
47·6	2,000	146	1,375,320
71·4	3,000	104	1,469,520

CONSTRUCTION OF CHARACTERISTIC.

From any point on the air space line lay off an abscissa equal to the sum of the abscissæ of points in the curves for armature, field, and pole-piece, whose ordinates are equal to the ordinate of the selected point in the air space line. This point will be a point in the characteristic curve. Any number of such points can be similarly obtained and the curve drawn through them. This construction does not take into account the effect of the current in the armature, as in this particular machine its effect is practically zero.

We have now all the data required to construct any size dynamo or motor of this type. Suppose, for instance, we wish to build a dynamo of this type with a given number of armature coils to give a certain potential at a given speed of rotation.

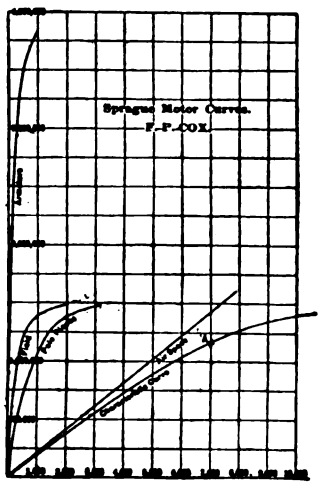
On the characteristic take A before the curve becomes too nearly horizontal. The induction for this point is 1,150,000, and the magnetising force 7,000 C.G.S. units. The potential this dynamo would develop at the given speed is given by the formula:

$$E = \frac{n r I}{100{,}000{,}000},$$

where

E = volts developed.
n = number of armature coils.
r = revolutions per second.
I = induction.

Now, this value is, perhaps, too small, and a larger machine will be required. Silvanus Thompson tells us that "if the linear dimensions of a dynamo be increased n times its output is increased n^3 times. This rule is only approximately true; so that when we select n so that $n^3 E$ = the required potential and construct a new set of curves, we shall find that they are not exactly right.



From this new characteristic we calculate the volts which would be developed at the stated speed, and find that it is either a little too great or small. Some small changes will have to be made in different parts, until, by successive approximation, the required potential is obtained. It is now necessary to know how strong to make the field. The magnetising force required to produce this induction is expressed by— $H = 4\pi n c$,

or $$n c = \frac{H}{4\pi};$$

but this is expressed in C.G.S. units, and will have to be multiplied by 10 to be expressed in units in daily use, giving the required ampere turns $= \frac{5H}{2\pi}$. A few words upon size of wire to use may not be out of place. We know the potential at the terminals, and can approximate to the external resistance, and, therefore, as to the current which will flow through the armature, and thus calculate the size wire required from the following rule: Wires to 2mm. diameter can safely carry five to six amperes per sq. mm., and wires of 5mm. diameter can safely carry three amperes per sq. mm. For the field, if it is a shunt machine, its resistance should be at least 364 times that of the armature, so that we can choose any resistance greater than this, only remembering that it must be the resistance of wire of proper size to carry the current, and of such length as to give the correct number of turns.

THE INFLUENCE OF HEAVY ELECTRIC CURRENTS ON TELEPHONE LINES.

The German Society of Electricians in November last appointed a committee to investigate the conditions under which telephone circuits can be efficiently operated in the neighbourhood of cables carrying heavy currents, such as are used for electric lighting and transmission of energy. The problem put before the committee was formulated as follows: (*a*) How are telephone currents influenced by heavy electric lighting and power currents in their neighbourhood? and (*b*) what conditions of installation and working heavy current circuits should be observed in order to avoid interference with neighbouring telephone circuits? The committee, as originally constituted, contained ten members, but they added four other members of the society to their number, and elected a sub-committee to prepare the experiments. The committee have now presented their report, which is printed in the society's *Journal* for August. The space at our disposal does not permit us to give a full translation of this report, and we must content ourselves with citing only a few of the experiments, and giving the general conclusions arrived at by the committee.

Experiment I.—The testing wire of an electric light cable 500 metres long, and carrying a continuous current, was used for telephonic communication, with the result that, in addition to the ordinary noises heard in the telephone, there was a disagreeable and persistent surging sound which greatly interfered with the clearness of transmitted speech.

Experiment III.—A telephone cable drawn through an iron pipe was placed underground at a distance of 1 to 1½ metres from, and for a length of 550 metres parallel with, several electric light cables carrying continuous currents. No noises, other than those usual, were heard in the telephone, and conversation over the telephone line was quite satisfactory.

Experiment IV.—In this experiment an overhead telephone circuit was used, passing over a railway station lighted by alternating currents. The telephone wire crossed the main cables at right angles, but was about 20 metres above the dynamo-room. Notwithstanding this disposition, there was produced in the telephone a humming noise which greatly interfered with the transmission of speech.

Experiment VIII.—An alternating current of 120 amperes was sent through a concentric cable, and an insulated telephone wire was laid underground by the side of it. No noises were heard in the telephone.

Experiment IX.—Instead of a concentric cable, two single cables were used, carrying a current of 58 amperes, and placed 15cm. apart, the telephone wire being laid midway between them. In the telephone there was noticed a low whistling sound, but not sufficiently strong to interfere with communication.

Experiment X.—The electric light circuit was arranged as in the previous experiment, but the telephone wire was placed outside of them, with the result of inducing a humming noise in the telephone which greatly impeded communication.

Further experiments were made to ascertain the effect of an iron armature on the cables, and a metallic return for the telephone circuit. It was found that telephonic communication remained undisturbed by neighbouring heavy

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currents if the lead sheathing of the telephone cable was used as a return circuit. Where, however, earth was used, noises could be detected in the telephone, and it was also found that the influence of heavy currents upon neighbouring telephone circuits depended upon the earth resistance of the latter.

The general conclusion arrived at by the committee is that it is not possible to give the precise limit for the distance at which parallel telephone circuits and cables carrying heavy currents should be placed in order to avoid interference, but that this distance should be made as large as possible, not only to reduce induction, but also with regard to the greater mechanical safety of the telephone circuits. Where alternating currents are used interference can be avoided only if both the positive and negative mains are equi-distant from the telephone circuit, a condition which is fulfilled by the employment of the Siemens' concentric cable. The same arrangement is also advisable where continuous currents are used. Interference is avoided if the telephone circuit is operated with a metallic return placed close to the outgoing wire. The report concludes with a recommendation that telephone and electric light or power circuits should be placed as far apart as possible, and should be protected by a metallic armature. It will be seen from the above brief review of the labour of the committee that the results they have obtained are in accordance with the generally accepted views on the subject, and that the recommendations are of such a nature as would naturally be adopted by any competent electric light or telephone engineer, even had these long series of experiments not been undertaken.—*Industries.*

ELECTRIC TRACTION.

M. G. de Coetlogon has recently contributed an article in *Le Génie Civil* on this subject, in which he gives a compendious account of the different systems in use. The author commences by pointing out that electricity substitutes for horses one central station equipped somewhat as follows:

1. Some kind of general motor.
2. Generating dynamos, or the charge in the case of accumulators.
3. A motor upon the vehicle operated by the power conveyed or stored.

The author claims that electricity presents a marvellous elasticity, in enabling the management to supply more or less power and velocity as required without an appreciable addition to the expense. And the further claim is made that "existing experiments show that the expense of electrical traction is 40 per cent. less" than by the use of horses for the same purpose.

Then follows a description of the three principal systems in use for moving the vehicle itself; leaving out of consideration here locomotives operated by electricity, as requiring a dead weight out of proportion to the service, and as presenting a waste of space in the length of the moving power.

1. *By Cogwheels (Frankfort).*—In this system a pinion, keyed upon the axle of the motor, meshes with a wheel, with 56 teeth, revolving upon an intermediary axle. A second pinion moves a wheel with 52 teeth, fixed upon the main axle of the car. The proportion is 6·6 to 1 between the motor and the driving wheels of the vehicle. This motor has a movement of about 500 revolutions per minute. The inconvenience of this system is that it is noisy, and easily broken or damaged.

2. *By Chain and Sprocket Wheel.*—In this machine the motor makes 1,000 revolutions per minute, and carries upon its axle a small pulley, the circumference of which is cut in V-shaped grooves. This pulley, by a belt of steel wires, controls a large wheel with similar grooving, fixed upon the frame of the car. The movement of this intermediate wheel is then transferred to the driving wheel by the aid of a pinion and a sprocket-chain and wheel. This is the system more generally used.

3. *By Steel Wire and Grooved Pulleys (Lichterfeld).*—Here the axle of the motor, fixed in the centre of the car, carries a pulley, in which the width is about 6in., and it is cut into twenty-four V-shaped grooves. Each of the two main axles of the car carries a large belt-wheel on its centre, with the rim of the belt-wheel cut with twelve grooves. The pulley is placed 2·95ft. from the centre of each of the two larger ones. In the grooves of the pulley run twenty-four cords of a special steel wire, which alternate so that twelve of these cords pass over each of the main pulleys. These steel cords are formed of two wires, each two millimetres in diameter, wound upon a core three millimetres in diameter, in such a manner as to make a rigid though flexible spiral cord of 5½ millimetres in diameter. This system is very simple and strong, and the carriage upon which it was first placed has already made an aggregate run of more than 248,000 miles without any breakage.

Motive Force.

There are three means of supplying electric energy to the car—viz.: (1) By primary batteries carried in the car. (2) By conveying the power to a distance. (3) By accumulators.

1. *Primary Batteries.*—Under existing circumstances this method must be rejected, as it is not commercially practicable on account of the weight, space occupied, and the delicate manipulation and other disadvantages.

2. *Transport of Energy.*—To this system belongs a central generating station provided with its general dynamos, and from which the electric force is conveyed to the car either by the rails themselves or by a special aerial or terrestrial conductor. If the transmission is by the rails, the axles are insulated from the wheels, and the motor receives the current from the dynamo generally by metallic brushes striking upon wheels which roll upon the conducting rail.

When the transmission is by aerial or underground conductors, the latter being enclosed in a buried tube with an upper slot, a small chariot hugs the conductor in the tube, or runs on wires supported on poles; and by a flexible cable conveys the electric current to the car-motor.

This transport system, more generally applied at present than the accumulator system, works very well, but there is much waste of energy in the transport. The resistance of the conductors being generally great, it is necessary to employ currents of high tension, which during their passage may cause accidents.

MM. Pollock and Binswanger have devised a special and ingenious arrangement, which seems to reduce the dangers above referred to. This is an insulated cable conductor, brought into action by a powerful magnet suspended under the car, with a third sectional and articulated rail. On the passage of the car, the attraction between the third rail and the magnet establishes between the cable and the rail a temporary contact, which ceases altogether when the vehicle has passed by.

Another inconvenience of the transport of electric energy by conductors is the waste of power, which increases with the distance from the central station. The longest line now operated on this system is that of Portrush, in Ireland, about 5·9 miles in length.

3. *Accumulators.*—This is the most seductive of all the systems proposed. By it the vehicle is rendered independent; it carries its own force within it to any desired distance according to the power stored. It is not tied to the bank, so to speak, by a wire or rail, for it may even leave the rail proper, and still be self-moving. If the places in this car are not all taken, the reduction in weight is a gain, for the car charged to run only 50 miles may possibly be transported twice that distance with the same reservoir of electric force. This mode of traction permits of a decrease in the length of the run by an increase in the normal velocity, and can command at will the extra power required for mounting grades.

Unhappily, the gain in power means an increase in dead load, due to the accumulators, and there is a commercial limit in this direction. It is true that this disadvantage is not peculiar to electric traction, for any other system of mechanical traction, by steam or compressed air, is subject to the same fault.

In present experiments in this direction the batteries are disposed under the seats in the car, or under the floor. To assure a force sufficient for a daily run of forty-eight to

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sixty miles for each car, it is necessary to arrange the batteries so that they can be readily replaced by new ones when emptied of their charge. And owing to their weight and the limited space in which to carry them, an electric capacity equivalent to 28 to 30 miles' run is the practical limit. The battery of accumulators generally weighs about one-third of the total of the car, the passengers, and motor mechanism united in the case of a 30-mile run equipment. To supply 60 miles per day, the battery will equal in weight the whole useful load.

The only fault of this traction system is thus in the excessive weight required in the dead or non-paying load, or the weight of the lead accumulators which Messrs. Julien and Reckenzaun employ. While they have attempted to reduce this load, the results do not yet give complete or sufficient satisfaction. The "horse-hour" stored weighs more than 110lb. When this can be reduced to 40, or better to 20lb., the accumulator system will be commercially practicable. In present practice the accumulators are charged at the station by the use of a dynamo and then put in place upon the tramway; one battery is recharging while the other is in service.

Existing Electric Traction Enterprises.

1. *Elevated Railway (in New York)—Transmission by Rail.* The experiments during the last two years on the Third Avenue Railway were on a line about 20,000ft. long. Traction was secured by a locomotive of the Steven and Field system, weighing 26,000lb.; of this 18,000lb. was in the motor. This engine draws three cars and 300 persons with a mean velocity of 7·8 miles per hour. The electric current from the generating dynamo was 40 amperes, with E = 800 volts—say, an electric energy of 32,000 watts-hour.

Electric Railway in Minneapolis, U.S. Transmission by Rail.—This line is a little over one mile long. It was intended to replace a section of ordinary railway over which the authorities had forbidden the use of steam. Each train is made up of three or four cars, transporting 600 people, of a total weight of about 90 tons. The speed is 16¾ miles per hour with a motor of 40 h.p.

Other American Lines.—Besides these two lines there are more than fifty towns in the United States having electric railways of some kind. All are in regular use—have been for some time—and give satisfactory results. The mean expense per car-mile is 3½d. to 4d.

Blackpool Railway (England). Transmission by Conduit.—This line is about 2 miles long. The rolling-stock consists of various types of carriages containing 30 to 56 passengers. The initial E.M.F. is 220 volts, which are reduced to 158 at the extremity of the line. The motor-engine is of 50 h.p., and the expense per car-mile is about 4d.

Portrush Railway (Ireland). Transmission by a Third Central Rail.—This line is 5·9 miles long. The generator at the central station is an hydraulic force of 100 h.p. The dynamo-generator gives a current of 100 amperes, with a tension of 250 volts. The motor-car will carry fifty passengers, and haul three cars of freight.

Bessbrook Line (Ireland). Transmission by a Third Central Rail.—Here the main generating force is also hydraulic, supplying 62 h.p. to two dynamos, credited with 100 amperes and 250 volts. This railway does regular duty in the transport of passengers and merchandise. The average speed is 8·7 to 9·3 miles per hour upon an undulating route of three miles in length. The motor-car will carry 40 passengers, and each of three waggons making up the goods train will carry 2 tons. In 1887, with 1,000 trains, the line transported 150,000 passengers and 1,500 tons of merchandise. The total expense of traction, including salaries, repairs, sinking fund, and motive-force, is about 4d. per train mile.

Brighton Tramway (England). Transmission by Rail.—This road has been in service since August 2, 1884, and runs from Brighton to Kemptown. The line has very steep grades, and a total length of about one mile. The motor-car carries 30 passengers, and weighs 10,450lb. The average speed is eight miles per hour. The service is very active in summer, and almost nothing in winter. Last year it transported 200,000 passengers. The expense per train mile does not exceed 3½d. The central station has a gas-engine of 12 h.p. driving a dynamo generator giving a current of 20 amperes with an E.M.F. of 160 volts.

Moedling Line (near Vienna). Aerial Conductor.—This line is 2·8 miles long. The line is one succession of grades, and the difference in elevation between the extremities is 1,180·8ft. All the expense of motive power is in the ascent, as the train returns by gravity, controlled by powerful brakes. As at Brighton, the important traffic is in summer. From April to November, 1887, it transported 350,000 passengers. The car weighs 8,800lb. net, and carries 25 people; a total weight of about 12,760lb. The ascent is made in 16 minutes, or at the rate of about 10 miles per hour. The electrical station includes three engines of 12 h.p. and six dynamos, each giving a current of 30 amperes with an E.M.F. of 500 volts. The potential difference is 500 volts at the Moedling station to 290 volts at the summit of the line. The average expense is 3½d. per mile run.

Frankfort Railway to Offenbach. Aerial Conductor.—The road has a regular service of 4·1 miles, with steep grades. Trips are made every twenty minutes; and the run is made in forty minutes, thirty-two for traction, and eight minutes consumed in eight stops. The line has been working since 4th April, 1884. The expense is about 4d. per mile run. Each carriage, with its dead load and passengers, weighs 18,370lb., and carries 48 people. In 1887 it transported more than 1,000,000 passengers. The central station utilises two engines of 60 h.p. and four dynamos, giving each a current of 70 amperes with an E.M.F. of 300 volts.

Lichterfelde Railway (Berlin). Transmission by Rails.—This is the oldest of all electric railways, having been opened on May 12, 1881, between Lichterfelde and the military school. The line is 1·5 miles long, and the carriage carries 24 passengers, and weighs, in all, 10,560lb. It makes the run in eight minutes at an average speed of 11 miles per hour. Each car makes 24 trips per day regularly; or a total daily run of 36 miles. It carried over 100,000 passengers last year. The plant includes two steam-engines of 6 h.p. and two Siemens' dynamos.

The author confines himself to the description of the above lines, as other existing lines are only copies of these.

Traction by Accumulators.

Rochdale Railway (England).—This line is about 3·1 miles long, with steep grades (111·5ft. difference of elevation). The carriage is very light, weighing only 4,400lb., and comprises in itself transmission motor and brakes. The battery is made up of 80 accumulators, weighing 39·61lb. each, or about 3,300lb. for total weight of battery. The carriage capacity is 20 passengers of 156lb. each, so that the total weight to be hauled is about five tons.

The electric motor has a nominal power of 10 horses and weighs 594lb. This machine makes 1,000 revolutions per second, with a maximum current of 40 amperes and 160 volts. This velocity is reduced in the ratio of ten to one by a transmission made by an intermediate axle and sprocket-wheels and chains. A compensator is arranged to bring reserve power into action; so that in case of breaking away on a steep grade a force of 12 or 15 h.p. can be commanded.

Electric Tramways of Brussels.—There are two lines here that have been in regular service for two years past. One runs from the Place Royale to the end of the Rue Beliard and the other is in the Parc au Rond-Point. Each line is about 2¼ miles long, and each car makes 12 round trips per day. The weight of one car and 30 passengers is 15,200lb. in total. The accumulators number 100 of the Julien system; and these are mounted either 100 in tension, or 50 in tension and 2 in quantity. There are two sets of accumulators so that they may be exchanged, and each set has an electric energy capacity of 31 miles as a maximum. Each battery weighs 3,300lb. The station plant includes a main motor of 150 h.p. driving four dynamos, each giving 200 to 500 volts.

Hamburg Tramway.—This was built by the same company as that at Brussels, and differs little from that one in detail. It runs from Rathhausmarkt to Bambek. As at

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Brussels, the carriage complete, with 32 passengers, weighs 10,120lb., and the battery of 100 Julien elements weighs 3,300lb. The transmission of power is accomplished by belts, intermediate axle, and sprocket wheels and chains. The speed of the motor is regular, and varies with the manner of putting the accumulators in circuit. There are likewise two sets of batteries, each having a capacity of thirty-one miles. Each car runs about sixty-two miles in total per day.

Newcoves Tramway.—This line is 1·97 miles long, with gradients of 30 and 40 per cent. The motor car, which in case of need can haul a second lighter car, has a net weight of 6,160lb. The transmission is by the Lichterfelde system of steel cords; and this apparatus, with the 10 h.p. motor, weighs 1,100lb. The car will carry thirty passengers. Each set of batteries weighs 3,300lb., and the total weight to be hauled is about 14,000lb. The average speed of the car is 7·8 miles per hour. Each vehicle makes ten round trips daily.

The following table sums up the different typical lines:

(1) Traction of train by locomotive (New York and Minneapolis).
(2) ,, by transmission of energy by cables (Frankfort).
(3) ,, ,, by cables with steep grades (Moedling).
(4) ,, ,, ,, rails (Lichterfelde).
(5) ,, ,, ,, ,, (Brighton).
(6) ,, Tatham accumulators (Rochdale).
(7) ,, Julion ,, (Brussels, Hamburg).
(8) ,, Green ,, (Newcoves).
(9) ,, Copper ,, (experimental on paper).

The author's conclusions are thus given:

(1) *Traction by Transport of Energy.*—There is no sensible difference between the use as a conductor of the aerial cable or the rail. The work performed by the machine generating the initial force, with dynamos generating electricity, being assumed as 100, the loss by transmission of force from engine to dynamo is at least 30 per cent. The electric energy sent by the dynamo to the electric motor on the vehicle will be about $100 \times 0{\cdot}70 = 70$; the loss by transport is about 40 per cent. With these two assumptions the motor will only then receive $70 \times 0{\cdot}60 = 42$. The transformation of this electric energy into mechanical work will occasion a new loss of effect of at least 28 per cent.; and the driving-wheels can thus only utilise 72 per cent. of the 42 available; or, say, 30·24 of the original 100.

To summarise the above, it may be said that the driving-wheels on the car only utilise on an average:

78 per cent. of the work furnished by the motor.
40 ,, ,, of that furnished by the generating dynamo.
30 ,, ,, only of the initial force from the main engine.

(2.) *Traction by Accumulators*—Assuming, as before, 100 as the work done by the engine generating the initial force, the average loss in transmitting this force to the generating dynamo is 30 per cent. The energy furnished by the dynamo to the accumulators is then $100 \times 0{\cdot}70 = 70$. The loss by transmission of the battery energy is 30 per cent. again, so that the motor can only dispose of $70 \times 0{\cdot}70 = 49$. To transform this electrial energy into mechanical work will bring about, as before, a further loss of 28 per cent.; so that the useful mechanical effect upon the wheels is only $49 \times 0{\cdot}72 = 35{\cdot}28$ of the original 100. To summarise as before, we have:

The driving wheels can only on the average utilise:

72 per cent. of the electric energy furnished by the motor.
50·04 ,, of that furnished by the accumulators.
35·28 ,, of the initial force from the main generating engines.

FACETIÆ.

IRISH.—It is said that the electrical officials at the Irish Exhibition have a special pass. Attendant: "Not by the turnstoiles, sorr; you go in by the entrance out."

WHAT MADE THE NOISE.—In a photographic studio where the latest innovation in the shape of an arc lamp of five thousand candle power was used to obtain the greatest artistic effect, a lady having her photograph taken enquired the cause of the occasional strong hissing noise made by the lamp. The photographer informed her that it was the carbons feeding. "I wish you would feed them before business hours, then," she replied. A fact!

THE PROTECTION OF ELECTRIC LIGHT STATIONS FROM LIGHTNING.*

BY W. J. JENKS.

Early in June a circular was issued from the Standardising Bureau office to each Edison illuminating company, asking what method of protection, if any, had been adopted and what results attended its operation. Up to Saturday night last, answers had been received from 59 central stations, demonstrating the lively interest taken in the subject and the fear of a peril little understood and possibly very difficult to guard against.

I shall have time to-night to consider only very briefly and imperfectly some possible causes of the almost unaccountable freaks of lightning flashes. In endeavouring to illustrate the more common, I shall refer to the remarkable experiments made and papers read within a few years by Prof. Hughes, and within a few months by Prof. Lodge, the latter being recently illustrated before the Society of Arts, of London.

I have shown some of the results which have been produced by a charge carried without any serious heating of a No. 12 B. and S. iron wire; also the prodigious energy expended in the twinkling of an eye by a current of suffi cient amperes to melt what was probably a poor joint or a corroded spot in a solid rod half an inch in diameter.

It is probable that, no matter how peculiar the track taken, the lightning always follows Ohm's law strictly, choosing the line of least real resistance. Several paradoxes at once appear. It is observed that in cases of burnouts of armatures the lightning spark appears to jump from one commutator bar to the shaft, and so to earth, or, perhaps, again from the shaft to an opposite bar, escaping by the conductor of opposite polarity; or, if it pierces the insulation of the coils, it usually jumps from an outside wire nearly midway of the length through intervening layers, straight to the core or shaft, but without following the wire through a circuitous route. This is shown graphically in the sketches, Figs. 1, 2, and 3—the first showing the armature construction, the second a relay, say, of five ohms, shunted by an air space of $\frac{1}{8}$in., and the third a loop of heavy copper, its ends close together. All embody the same idea, that of the enormous increase of the resistance offered by a conductor to the passage of a current through electrical inertia or self-induction.

Water in a pipe cannot be started into rapid motion in an instant. A very quick and violent blow upon the water may burst the pipe, but will not propel the water. If you apply enormous power suddenly to the piston of an engine having a driving pulley weighing several tons, you may break some portion of the machine, but the inertia of the wheel must be gradually overcome. So it is with a rush of such inconceivable velocity as lightning, for we must remember that practically, and for aught we know absolutely, the E.M.F. of any electrical flow is simply its velocity, and a tension of 1,000,000 volts means that the impulse is toward a velocity 1,000,000 times as great as with one volt. The flash occurs, and with such suddenness that the metallic particles cannot adjust themselves to transmit the motion as quickly or as easily as a narrow air space. Hence, while the resistance offered by a heavy copper loop to a current of low velocity is as nothing, its resistance to a momentary discharge of very high velocity may be beyond our power to compute, and a side flash takes place to any available conductor.

Again, let us consider the stored energy of a highly-charged thunder-cloud as analogous to the pent-up forces of a steam-boiler at high pressure. Liberate either and rapid motion results. The energy of each can be expended only in one way—namely, as arrested motion, and the energy of arrested motion always appears as heat. If we give the steam a broad free opening, its velocity of expansion is frightful, and after the first impulse it recoils and surges and oscillates back and forth until its energy is dissipated. If the opening be small and the friction of the discharge be great the high pressure of the minute jet will be gone by the time it meets the outer air. So with the electric discharge. The outburst of great velocity recoils along the

*Abstract of paper read before the Association of Edison Companies.

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conductor and oscillates back and forth until its pressure has gone into heat and equilibrium is reached. There may be millions of these oscillations in a second, for they all take place within the $\frac{1}{100000}$ of a second, which represents the duration of the discharge.

One more surprising thing has been developed from the theory of Clerk-Maxwell by Prof. Hughes, Lord Rayleigh, and others, and clearly stated by Prof. Lodge. It is that when a current starts in a conductor it begins on the outside, and gradually, though rapidly, penetrates to the interior. A steady or direct current, once started, flows uniformly through the whole section of a conductor; an oscillating or alternating current does not. It is started first at the surface, and it is stopped there first. With rapid alternations, then, lightning cannot penetrate below the skin, as it were, of the conductor. In this outer skin of microscopic thickness electricity may be oscillating while the interior is idle, and the real conducting substance is confined to the surface. This is a fact distinct from the old one, that static charges dwell only on the surface.

In Prof. Lodge's experiments with a constant E.M.F. and with resistances, explained in his lectures to the Society of Arts, the distances which sparks would jump were shown.

Two surprising hindrances are apparent, the electrical inertia, which does not act as resistance, by using up energy and radiating heat, but causes a dodging or side flash, and the similar effect of a throttling nature resulting from surface action, which does dissipate energy as heat. These combine their forces to resist the passage of lightning along the best of conductors.

How, then, may we best guard against this, until recently, unsuspected effect?

1. By making the conductor in the form of a ribbon instead of a rod. This advantage can be approximated by using strands of fine wires. Experiments show very little difference with conductors of small size, so far as melting with large currents is concerned, but this is not the point. With lightning there can be no time for surface cooling. If the conductor has literally too much current to carry it will melt instantly, no matter what its surface as compared with its mass. The difference between a tape and a rod is shown to be at least 25 per cent.

2. By making it of iron in preference to all other metals. It may be objected that iron has more self-induction than copper; that is, a current going through iron has to magnetise it in concentric layers, and this takes time and develops inertia.

It appears likely that the alternations are too quick to magnetise the iron, or the current operates so entirely on the surface that there is nothing to magnetise; at all events, a coil made of tin-foil requires the same E.M.F. to give the same length of spark when it is placed in the circuit of a Leyden jar discharge, whether it has a bundle of fine iron wires as a core or not.

Even with these precautions, side flashing and jumping from the rod cannot be entirely stopped. No matter if it be made a foot or a yard wide, the increasing of resistance in a side path serves not to stop the flashing, but only to weaken it.

3. One more remedy suggests itself, viz., giving the conductor as much capacity as possible. Such a condenser as Mr. Edison suggests provides a very large surface for interchange, a storage ground, as it were, where the energy can be momentarily accumulated by charging up the plates, and the violence of the disruptive spark somewhat broken. If by any means we can thus slow down the velocity of the discharge, we avoid much of the danger of the side flash, which punctures our armatures, and allows the line current to follow and melt them.

In this connection a most interesting diagram may be briefly explained. When a gradual charging has taken place, and a ground wire or rod is awaiting the flash from the cloud, we have an effect which may be described as "steady strain." Experiment shows that a flash will jump three times as much air and encounter a megohm resistance rather than take the short direct path offered by the equivalent of a large knob (about two and a quarter times as large in diameter as the smaller one). If we interpose into one of the conductors a resistance, equivalent to a bad ground connection, we find that up to a certain point the worse a conductor is, the quieter (and less explosive) will be the flash (while the energy or heating effect remains substantially the same), and the protection, if the current is led to the right spot, will be as good. The potential which has to be absorbed or used up, is expended more gradually.

But often the clouds spark first into one another, and then as a sort of recoil into the earth. An upper may spark to a lower, and instantly this overflows into the earth, and the conductors previously uncharged do not have time to prepare any carefully-chosen path by induction. This is a sudden rush, and the effect is radically different. The best and highest conductors will be struck with equal ease, no matter what their shape or size, and probably all three will be struck at once. Now insert resistance into one and its protective power disappears. It may even penetrate the cloud, but it assists very little, if any, in discharging it. So a bad ground cannot protect against these explosive discharges.

Where a bolt strikes a system and discharges at the central station, it rushes to the ends of the system, for instance, to the open-ended conductors, such as spur mains, brings up with a tremendous water-hammer action, surges back like water in a pipe, and thus expends an enormous amount of energy before it settles to an equilibrium. Hence complaints are frequent that these long spur mains especially have lamps exploded, plugs fused, insulating joints punctured, and flexible cords short-circuited by lightning. Imagine a rubber hose, somewhat elastic, pumped very full of water, and its ends closed with spring valves. If one end is suddenly opened and as suddenly shut, a pulsation or recoil is sent back which may force open the valve at the farther end and let some water escape. Thus the electricity, when a flash strikes the lines, goes rushing and surging about everywhere for no apparent reason, just as water surges about in a canal, splashing and overflowing its banks when rocks are dropped in. Bell-wires, gas-pipes, gutters, chains, bars and bolts take side flashes from the main conductors in a most bewildering fashion; thus gas ignites in most unheard-of places, and passengers in a train may feel a shock because a charge has struck the rails. Even the hinge of a door or an isolated nail may call a spark from nobody knows where. This manifestation of electrical inertia may even cause a secondary flash from the distant end of a conductor longer than the original spark, and the reason for what we are accustomed to regard as return strokes thus becomes plain.

Three kinds of damage may be said to be done to our electric light systems by lightning discharges:

I. Disruptive damage, or the expanding and explosive violence.

II. Melting or fusion by heat of the current or the arrested motion, which we may term the result of electric inertia.

III. By breaking down the insulation of apparatus, lines and fixtures, and establishing a bridge of vapourised metal or heated gas, which is followed up by the working current of the system. When a very good conductor is provided, except at a very few points, the disruptive or explosive action is commonly manifested at these intervals. When the general track of the tension resulting in a discharge is one of very great resistance, the flash appears slower and the heating effect is more pronounced.

Some of these effects have taxed the ingenuity of the brightest theorists in this field. A recent writer thus aptly expresses it: "When conductors fail it is customary to say that they are not properly made, or that there was a faulty joint, or that there was a bad earth. A bad earth is the favourite excuse. A good earth is a good thing undoubtedly, and one cannot well have too much of it, but for the flash to leave a fine thick copper conductor on a pole or chimney while still high up, knocking holes in the brick in order to make use of the soot or the smoke, or some bolts, or other miserable conductors of that sort, because it is not satisfied with the moderate allowance of earth provided for it at the bottom, is evidence either of simple perverseness, or else of something more deep-seated. If the earth is bad, the flash may show its disgust when it gets there by tossing it about and boring

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holes into it, and breaking the water and gas mains. But at least it might leave the top and middle of the chimney alone, and wait until it got to the badly-conducting place before doing the damage. It is supposed with one breath to strike the conductor because it affords an easy path to earth; and with the next it is said to leave the conductor because, after all, it finds it a bad one. Besides, it need not be so very particular about a little resistance. It has already come through, say, half a mile of clear air, and we may suppose that it might manage a few feet of dry soil. It is not possible to have too much good earth except on the score of expense. But even if it were so good an earth that it may be almost called a heaven, it would not stop the tendency to 'side flash.'"

A ground connection is desirable to prevent damage to pipes, foundations and everything buried therein, but so far as getting rid of the flash is concerned it ought to suffice if the conductor was cut off level with, or even a foot or two above, the proper locality on the ground.

To sum up regarding the construction of conductors for the protection of chimneys, station buildings, and lofty poles: First, the upper end of the conductors should be pointed. It is a fact that anything will act as a point when the potential has become sufficiently high, but the object of all lightning protection is to keep down this dangerous tension wherever possible. Sharp points will radiate energy rapidly and reduce the strain far below the sparking point. One point at the top of the rod is not sufficient to insure the best results. It may become blunted by a discharge, or tarnished. The best points are cones of copper not so sharp as to be readily fused, and heavily gilded to keep them always right.

Three forms of rods have been widely produced and each quite generally adopted—viz., the round bar of copper or iron, the rope or stranded metal, and the ribbon. The English Lighning Rod Conference of 1882 gave the preference to copper tape, which is easily handled, flexible, and free from joints. The rod should not be readily corroded; allowance should be made for expansion and contraction. With copper rods the expansion and contraction with the extremes of temperature in this country is due to a variation of at least 125° Fahr., and allowance should be made of at least $\frac{1}{100}$ of the length, or an inch for every 40ft. If bends are made sharp, lightning will be apt to jump across instead of going round the bend. Flexibility is convenient, but should not be too much relied upon, inasmuch as a straight track to earth is one of the most desirable features of the main leaders of a rodded system. If lightning is led to jump across instead of coming through the entire length of the conductor, melting will probably take place, and any sparking between the upper ends of the rod and the ground connection is always a serious danger. The main difficulty with poor joints is the tremendous heat developed, with the liability of fire communicating to any combustible material.

(To be continued.)

TELEPHONIC DEVELOPMENT.

[The following article from the *Financial News* treats on an important subject, and is stated to be a special report by one thoroughly conversant with the subject.—ED. *E. E.*]

Agreeably to your request, I have examined the various systems of telephonic communication in use in England and Scotland. I have treated the three great representative centres—viz., London, Manchester and district, and Glasgow and district—separately, and compared them with each other. I have looked at the subject from a technical point of view, but, as far as possible, treated it in popular language, the intention being that your readers should be enabled to judge of the relative merits of the companies concerned—viz., the United, the Lancashire and Cheshire, and the National—and of their management.

Beginning in the North, I examined first the National Company's system. This company has now in Glasgow 1,570 subscribers. The wires converge into six central exchanges, which are connected with each other by means of from eight to 25 junction wires. The wires are entirely silicium bronze of No. 18 gauge. This wire weighs only 35lb. to the mile, against 220lb. per mile in the case of the old Post Office wires and the telephone wires commonly seen in London. The wire has the peculiar quality of returning to its normal position immediately after the snow or frost has melted off, and it contracts or expands but slightly through the action of cold or heat. Being very thin, it collects little snow, and owing to its lightness can, if broken, do little or no damage in falling. The wires are carried over the housetops by means of iron poles which rest in sockets on the roofs, and are supported by stays of twisted galvanised wire. On the principal routes five iron poles, with arms stretching across, after the pattern of a gridiron, are used. Thirty-two wires are fixed on each cross-bar, so that the five iron poles carry nearly 1,000 wires. As the distance from the exchange increases, and the number of wires becomes less, the poles are reduced to two with 30 cross-arms carrying 10 wires each. Further on, still, a single pole with 20 cross-arms carries upwards of 100 wires. The wires are attached to the arms by means of single porcelain insulators, and every joint is soldered. The use of these insulators and the soldering of the joints is of much value in producing good talking. In this connection it may be mentioned that every earth connection is also taken, regardless of distance, to the nearest water-pipe and there soldered. The intercommunication, or "switching," is accomplished in the central offices by means of the so-called "multiple" board system.

Your readers are no doubt aware that a certain number of subscribers in every telephonic exchange is allocated to each of the operators in the central offices. The wires of these subscribers are all collected upon one "table," by which means they are grouped under the control of this operator. The advantage of the "multiple" board system is that, while under the old plan great difficulty was found in practice in joining wires from table to table—that is to say, connecting with each other the groups worked by the various operators—under the new plan each wire has a connecting wire to each other wire on each table. It is difficult to convey on paper a clear idea of how this is done. The plan, though effective, is very costly, a multiple board capable of carrying 2,000 subscribers' wires requiring 400,000ft. of these connecting wires. Great quickness in service results, however, as every operator has under direct control a branch wire to the wire of every other subscriber in the central exchange. All the ringing from the exchange is accomplished by means of magneto-electric generators worked by a small turbine, the power for which is got from the ordinary water mains. Each operator has a key or switch connected with this ringing apparatus, and can thus use the currents at will upon any line required. One operator is found to be able to attend in Glasgow to about 60 subscribers. As regards the subscribers' end of the wire, each subscriber is provided with a magneto ringing apparatus for the purpose of attracting the attention of the operator. The old and costly system of ringing by means of batteries has been entirely discarded.

There is no special contrivance in Glasgow by which a subscriber can notify to the operator that his conversation is at an end. In Dundee the company has adopted a system which enables every subscriber to put himself at once—even, say, in the middle of a conversation with another subscriber—in communication with the central office. This system works well, and has been of great benefit in promoting quick service. The vexatious delays which occur when, as is too often the case, a conversation is interrupted by the central office under the impression that the interview is over, are impossible under this system. No telephonic system can be considered complete unless it embraces some contrivance for this purpose.

Overhead cables are little used in Glasgow. In this respect Manchester, as will be seen later on, is ahead. The whole of the National Company's system, even down to the smallest exchange in a country town, is open all the year round, night and day. Glasgow is connected by means of trunk lines with all the neighbouring towns of any importance; indeed, all the principal towns in Scotland can either now, or will be able very shortly, to communicate by telephone with each other.

The Manchester telephonic exchange system differs in many ways from that of Glasgow. There are 1,350 subscribers, and the whole of their wires have been concentrated in one central exchange. The wires, which are hard-drawn copper of No. 18 gauge, are carried over the housetops by means of wooden standards, with two poles and ten cross-arms, each supporting fifteen wires. On the routes requiring fewer wires single wooden poles, with ten wooden arms carrying eight wires each, are used. Single and double shackles insulate the wires. Glover's anti-induction 20-wire cable plays an important part in the outside wiring, and is found to be very successful. Along one route there is one of these lead-covered 20-wire cables one mile in length, the induction on which is said to be imperceptible. Several hundred wires are carried in this manner in many directions from the central exchange. Your readers are, no doubt, aware that it is owing to "induction" that one subscriber can overhear the conversations of another. Hence the importance of avoiding it in telephone work.

The multiple board has been introduced in Manchester with good results. The ringing from the exchange is accomplished both by means of magneto-electric machines driven by water power

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and also by means of batteries. A most convenient test-board receives all the wires as they come in from the roof. It is arranged so that by inserting a small plug the wire is disconnected either on entering or leaving the test-board. By this means all the wires can be at once tested, and if not found to be in working order they can be repaired, it may be before the subscriber has discovered the fault. All the neighbouring towns of Lancashire and Cheshire are connected to Manchester by means of trunk lines. A special charge is made for each conversation on these trunk lines, and monthly accounts for these charges are rendered to each subscriber. In order to prevent disputes the particulars of these connections are written on a slip of paper, and this slip is placed in a small machine, which stamps on it the date and the time to a minute. Three operators attend to 200 subscribers.

A special feature of the Cheshire Company's system is the use of what are called "polarised indicators." I can only hope to explain the effect of these to your readers, an idea of the mechanism not being easily conveyed. To attract the attention of the central office, each subscriber has a battery of four cells, which is put in action by one of two push buttons—the one white and the other black. The white button sends a current which calls the attention of the operator in the usual way, thus notifying that the subscriber desires to be connected with some other subscriber. The operator having placed him in communication and his conversation being over, by means of the black button he is enabled to notify that the conversation is at an end, and in any case to make it clear in the central office that it is to them, if to anyone, he desires to speak. In other words, he has a similar advantage in this respect to the National Company's subscribers in Dundee. But this is gained at greater expense to the company, as the apparatus and accessories are costly and liable to get out of order.

It now remains to consider the London system, where there are now upwards of 4,800 subscribers to the United Telephone Company's exchanges. The wires are concentrated into some 20 different centres, about half of which have between 100 to 600 subscribers each, the rest having a small number. The largest exchange is in Coleman-street, where there are about 500 wires. Hard-drawn copper wires are now being used on new work, but the bulk of the work has been done with steel wire of No. 8 gauge, and where the largest numbes of wires converge they are attached to massive angle iron tower-shaped fixtures by means of single shackles. From each corner of these fixtures two sets of upwards of 50 wires each are led off in opposite directions. Thus each of these important fixtures are designed to carry only about 400 wires. The main routes are conducted over the house-tops by means of single iron poles, each having twisted wire stays to support it. The wires are arranged in one row, say, of 20 to 30 wires, reaching in a line from top to bottom of the poles, and are attached by clips and double shackles. Overhead cables are very much used, upwards of 25 of these leading away from the central City exchange. In three or more of the principle centrals multiple boards have been introduced, but in all the rest the original single-wire system remains. This, of course, entails delay, and is the cause of many of the instances of bad service which occur. The exchanges have hitherto been closed at nights and on Sundays, and are now only open in part for a continuous service. The subscribers to the London system use the original form of electrical ringing apparatus, operated by a battery—there is no separate arrangement for ringing off or calling the central office, and, in fact, no improvement of any kind has been introduced in this connection since the beginning. There has hitherto been no system of public call offices, and with the exception of Brighton and Tilbury, no towns are connected to London by telephone. The Tilbury wire is practically disused, and the Brighton wire has been so inefficient as to lead to no practical benefit. As regards trunk wires, in fact, London may be said to be quite isolated.

Having thus described shortly the representative centres of British telephony, and stated the plain facts in each case, let me make a short comparison of the results obtained by the companies. The question first of all arises, is it wise to concentrate all your wires into one central, as in Manchester, or to have many exchanges, as in Glasgow and London? Under existing circumstances, and unless some better system of inter-switching between exchanges can be introduced, Manchester takes the lead. It must be admitted that the expense of concentrating is very great; but still, in telephony, it is pre-eminently the case that the best service, although costly, is the one that will eventually pay the best. Then as to the wires, Glasgow and Manchester undoubtedly lead the way with silicium bronze and hard-drawn copper wires of a small gauge, which are better conductors, last longer, and exert only one-sixth of the strain resulting from the old-fashioned steel or iron wires so much in use in London. The next point is the fixtures on which the wires are carried. London again is found behindhand, for while Glasgow and Manchester carry from 100 to 300 wires on each main route, London *with practically, as regards wayleaves, the same outlay carries only 20 to 30.* The large angle-iron central standards are undoubtedly substantial, and even artistic in design, but quite unsuited for the purpose, while the only parts of the structures themselves which could conveniently and economically be used for carrying wires—viz., the flat sides—are not made use of at all!

In the manner of the attachment of the wires to the fixtures Glasgow stands first. Single insulators, as there invariably used, have eight times the insulation resistance of the double shackle of Manchester and London, and correspondingly good talking power. In cables Glasgow is left behind.

Descending to the switching-rooms, Glasgow and Manchester are on a level footing, whilst London is just awakening to the fact that improvements upon original types exist. Manchester and Glasgow have long had an all-night and Sunday service, while London has only just begun to follow them in this. With regard to the ringing-up systems with which subscribers are provided, undoubtedly the magneto system of Glasgow is the cheapest and most efficient. Still, Manchester, with the white and black buttons, has a great advantage. The London electrical ringing system is at once the most expensive and the least efficient, and has not even the redeeming feature of a special ring-off system, as in Manchester. In the matter of trunk lines, Glasgow and Manchester have been at work in earnest, while London has done in effect nothing.

With regard to the practical working, it may be stated generally that London is not to be compared with the others. The causes of the delays, the induction or leakage, and the continual disconnection during conversation, which renders the telephone in London comparatively useless, are to be found in the defects of the system, which, as I have shown, is in every point inferior to that in other centres.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ended August 24 amounted to £5,229.

Dissolution of Partnership.—Mr. H. E. Harrison, having retired from the firm of Phillips, Harrison and Hart, electrical engineers, of Westminster, the business will in future be carried on by Messrs. Phillips and Hart.

West African Telegraph Company.—The half-year's interest, due September 1, upon the five per cent debentures of the West African Telegraph Company, Limited, will be paid at the National Bank of Scotland, Nicholas-lane, on and after that date.

Western and Brazilian Telegraph Company.—The traffic receipts of the Western and Brazilian Telegraph Company, Limited, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, for the past week was £4,367.

Lancashire and Cheshire Telephonic Exchange Company.—The report of the Lancashire and Cheshire Telephonic Exchange Company, Limited, states that the subscriptions and rentals (including those of the out-districts) pertaining to the financial year, ended June 30, amounted to £89,797, as compared with £82,490, the amount of income carried forward as representing sums received in advance for periods extending beyond June 30 last being £40,377, against £38,276. The Directors recommend a further dividend at the same rate as in February, making a complete dividend of 7 per cent. for the year, leaving a balance of £5,420, of which they propose that £3,000 be placed to the reserve fund (making a total reserve, including interest, of £8,650), and that £2,420 be carried forward.

PROVISIONAL PATENTS, 1888.

AUGUST 17.

11,897. **Electrical indicators.** Oliver B. Shallenberger, Rochester, Pennsylvania, United States, or William Phillips Thompson, as a communication from George Westinghouse. (Complete specification.) (Date applied for under Section 103 of the Patents, &c., Act, 1883, 21st January, 1888.)

11,898. **Electrical indicators.** Oliver B. Shallenberger, Rochester, Pennsylvania, United States, or William Phillips Thompson, as a communication from George Westinghouse. (Complete specification.) (Date applied for under Section 103 of the Patents, &c., Act, 1883, 21st January, 1888.)

11,913. **Improvements in grapnels for raising submarine cables.** Francis Robert Lucas, 24, Southampton-buildings, London.

11,917. **Improvements in or connected with the transmission of electric energy.** James Grieve Lorrain, Norfolk House, Victoria Embankment, London, W.C.

11,925. **Improvements in electrical switches.** Herbert William Edlin, 53, Chancery-lane, London.

AUGUST 18.

11,929. **Improvements in electrical indicators.** Gustav Binswanger, 5, Great St. Thomas Apostle, London, E.C.

11,937. **Improvements in apparatus for driving dynamos and similar machines for electrical purposes.** Frederick Charles Lynde, 48, King-street, Manchester.

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11,939. **A new non-magnetic metallic alloy.** Heinrich Ostermann and Axel Prip, 68, Fleet-street, London. (Complete specification.) (Date applied for under Section 103 of the Patents, &c., Act, 1883, 16th February, 1888.)

11,941. **A new non-magnetic metallic alloy.** Heinrich Ostermann and Charles Lacroix, 68, Fleet-street, London. (Complete specification.) (Date applied for under Section 103 of the Patents, &c., Act, 1883, 25th April, 1888.)

11,963. **Improvements in or connected with electric rail or tramway systems.** Michael Holroyd Smith, 55 and 56, Chancery-lane, Middlesex.

11,965. **Improvements in anti-induction electric apparatus.** Jules Cerpaux, Pierre Borre and Léon Maertens, 33, Chancery-lane, London.

AUGUST 20.

12,010. **Electric signal lantern.** C. F. Emanuel Berg, 20, Johannes Strasse, Berlin. (The firm of Keiser and Schmidt, Berlin.)

AUGUST 21.

12,054. **Improved means for diminishing the injurious effects of induction currents in telegraphic and telephonic circuits.** E. Liebert and Sally Adolf Rosenthal, 45, Southampton-buildings, London.

12,063. **Improvements in or relating to electrical type-writers.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.) (Complete specification.)

12,064. **Improvements in or relating to electrical type-writers.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.) (Complete specification.)

12,065. **Improvements in or relating to electrical type-writers.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.) (Complete specification.)

12,066. **Improvements in or relating to electrical type-writers.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.) (Complete specification.)

AUGUST 22.

12,126. **Improvements in and relating to merry-go-rounds and the like, and in apparatus and devices in connection therewith, propelled and operated by means of an electric current.** Richard Richardson Hutchinson, 4, Little Moorfields, E.C.

12,127. **Improvements in and relating to electric motors.** James Feaveryear, 4, Little Moorfields, E.C.

12,129. **Improvements in automatic electric signalling for railways.** John Leman Eckersley Daniel, 68, Fleet-street, London.

AUGUST 23.

12,149. **An improved electric battery.** James Hargreaves and James Croft Sewell, 4, Clayton-square, Liverpool.

12,155. **A new or improved application of electricity to the manufacture of soap.** Robert Scott and Charles Richard Held, Market-place, Huddersfield.

12,157. **Improvements in portable electric lamps with combinations.** John Samuel Ross, 72, Hammersmith-road, West Kensington, Middlesex.

12,158. **Improvements in working railways by electricity.** Charles Ernest Spagnoletti, 21, Cockspur-street, London, S.W.

12,163. **Improved cell or containing vessel for electric batteries.** Henri Georges Charles Serrin, 46, Lincoln's-inn-fields, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

AUGUST 24, 1887.

11,543. **Improvements in electrodes for electric accumulators or secondary batteries.** Henry Tudor, 6, Lord-street, Liverpool.

SEPTEMBER 13, 1887.

12,414. **Improvements in electric arc lamps.** Frederick Carrington Phillips and Hugh Erat Harrison, 2, Victoria Mansions, Victoria-street, Westminster, S.W.

SEPTEMBER 20, 1887.

12,763. **Improvements in electric meters, or apparatus for measuring electricity.** George Forbes, 34, Great George-street, Westminster.

OCTOBER 13, 1887.

13,853. **Improvements in and connected with telegraphic apparatus for transmitting orders, or other communications.** George Alexander Calvert, 87, St. Vincent-street, Glasgow.

OCTOBER 14, 1887.

13,978. **Improvements in electric firing gear for rapid firing and other guns.** Andrew Noble, Jesmonddene House, Newcastle-on-Tyne.

OCTOBER 24, 1887.

14,416. **Improvements in telephonic apparatus.** John Lorimer Corbett, 62, St. Vincent-street, Glasgow.

NOVEMBER 2, 1887.

14,954. **Improvements in apparatus to be used in the deposition or treatment of metals by the electrolytic process.** William Terrill, 55 and 56, Chancery-lane, Middlesex.

JUNE 12, 1888.

8637. **Improvements in electric clocks.** Albert Lyman Parcelle, Boston, Massachusetts, United States.

JULY 23, 1888.

10,631. **Improvements in electrical night-signalling apparatus.** Emil Kaselowsky, 6, Bream's-buildings, London.

SPECIFICATIONS PUBLISHED.

1887.

10,200. **Dynamo-electric generators and motors.** H. C. Bull and Co, and H. C. Bull. 8d.

12,823. **Telephonic arrangements, &c.** A. A. Campbell-Swinton. 8d.

13,207. **Indicators for electric bells.** A. Morley and H. W. Wilson. 8d.

13,221. **Controlling automatically armatures, &c.** J. H. Holmes. 8d.

13,333. **Secondary generators, &c., of electricity.** J. D. Gibbs and E. Fesquet. 8d.

13,338. **Electric lamp attachments.** W. Hartnell. 8d.

1888.

4759. **Telephonic apparatus.** H. H. Lake (International Dudley Signal Co.) 1s. 3d.

9332. **Electrical connection of railroad rails.** F. Stitzel and C. Weinedel. 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday.
2 July	4%	African Direct 4%	100	101
12 Feb.	1/2	Anglo-American Brush E.L.	4	3½
12 Feb.	2/0	— fully paid	5	4½
27 July	1%	Anglo-American	100	41½
27 July	2%	— Pref.	100	68
12 Feb., 85	5/0	— Def.	100	13⅜
28 June	3/0	Brazilian Submarine	10	13½
14 June	1/0	Con Telephone & Main	1	1⅛
10 Aug.	9/0	Cuba	10	13¾x
10 Aug.	10/0	— 10% Pref.	10	19½
28 Mar.	2/2½	Direct Spanish	5	4
28 Mar.	5/0	— 10% Pref.	5	10½
27 July	2/0	Direct United States	20	9½
27 July	4/6	Eastern	10	12½
27 July	3/0	— 6% Pref.	10	15
1 Aug.	5%	— 5%, 1899	100	110
26 April	4%	— 4% Deb. Stock	100	108
12 July	2/6	Eastern Extension, Australasia & China	10	13½
1 Aug.	6%	— 6% Deb., 1891	100	107
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	103
28 Mar.	8/3	German Union	10	9½
10 Aug.	3/0	Globe Telegraph Trust	10	6⅝
10 Aug.	3/0	— 6% Pref.	10	14x
30 April	5/0	Great Northern	10	14¼
30 April	5%	Gt. Northern 5% Deb., '83.	100	109
27 July	10/0	India Rubber, G. P. & Tel.	10	17½
11 May	37/6	Indo-European	25	39
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅝
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
		Swan United	8½	2¼
10 Aug.	13½%	Submarine	100	140x
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39½
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	8
1 Mar.	5%	— 5% Debs.	100	99
12 July	4/0	West Coast of America	10	7
30 June	8%	— 8% Debs.	100	115
11 May	9/0	Western and Brazilian	15	12
11 May	6/10½	— Preferred	7½	7
11 May	2/1½	— Deferred	7½	5½
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	1⅜
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80		— 6% 2nd Pref.	10	9½
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	105

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NOTES.

Cable or Electric.—Electric cars can be worked on gradients up to 10 per cent. Anything over this is the right place for a cable system.

Turin Theatres.—The authorities at Turin have issued notices that all theatres not lighted by electric light by the 1st of November will be closed.

Lightning Arresters.—The Thomson-Houston Company always use lightning arresters in their tramcar motors. Several motors of other companies have been burnt out.

Unter den Linden.—On Thursday August 30th the magnificent street of Berlin, Unter den Linden, was lighted for the first time by electric light. The effect was very fine.

Thomson-Houston v. American Co.—A cablegram this week states that a judge's order has been granted restraining the American Co. (Fuller-Wood) from sale or shipment to England.

Whitworth Scholarship.—Mr. B. Young, 23, electrical-engineer apprentice, Belfast, has obtained a Whitworth exhibition, tenable for one year, of the value of £100, and also a Royal exhibition.

Electric Roads in Great Demand.—It is a very small and lifeless town in the west of America that is not now agitating the establishment of an electric street railway, says the *Western Electrician*.

Chatham.—The local electric lighting company have this week been busily engaged in putting up wires in High-street, Chatham. The circuit is now almost complete, and lighting will be commenced in a few days.

Telegraph Trust.—A rumour is afloat that a gigantic telegraph trust will be formed on the other side of the Atlantic. Jay Gould proposes to sell out his interests to a syndicate composed of the owners of the cable companies.

Bridlington Quay.—At the Local Board meeting on Wednesday, the question of lighting the Sea-wall Parade with electric light was brought forward, and a resolution passed instructing the committee to ascertain upon what terms it could be done.

Bath.—The Bath Gas Company, stimulated by the recent decision in favour of electric lighting, has decided at their own expense to fix some improved lamps to show what they can do when put to it. The electrical engineers, however, are not despondent.

Sea Telegraphy.—Wanted, an inventor to devise a practical apparatus for ships whose indicator shows whenever the ship approaches another vessel carrying a similar apparatus. A practical marine signalling apparatus of this description would have a wide application, and save many lives and much money.

The Hall Electric Pump.—Referring to the Hall electric pump, illustrated on page 544 of our issue of June 8, Messrs. Woodhouse and Rawson inform us that they are now in a position to quote for supply of this pump in England, and the prices and description will be inserted in the list now preparing.

Death of Dr. Clausius.—The eminent professor of the Bonn University, Dr. Clausius, died on the 24th of August. He was born in Pomerania in 1822, and attained world-wide celebrity as the demonstrator of the mechanical theory of heat. Among purely scientific men few are more honoured than the famous Professor of Natural Philosophy.

Railway Induction Telegraph.—The telegraph departments of the Union Pacific and the Western Union are going to give a trial to the system of telegraphing to trains in motion adopted on the Lehigh Valley roads. There is probably a good paying line in this direction for our railway electrical engineers to take up in this county.

Found Dead.—A man and his wife were lately found dead in Chicago. The man had hung himself, but there was no indication of the manner of his wife's death. It is thought that the wife was killed with an overdose from a powerful magneto machine that they were in the habit of using, which was on the premises, and that the husband, fearing consequences, committed suicide.

Suspended Electric Railway.—The novel electric tramway we described lately is to be put in practice at St. Paul, Minnesota. The railroad is an elevated structure, and the cars are hung below it close to the street level, and take their power from the overhead wheels. It may be said to be a kind of passenger telpher line. The speed claimed is from eight to ten miles an hour.

Mineral Wool Regulator.—An invention for the regulation of electric circuits has been patented in America by Messrs. J. Vansant and Frank Anderson. This consists of a variable resistance composed of carbon and mineral wool which can be compressed in the containing receptacle by the means of adjusting screws, thereby diminishing or increasing the strength of the current.

Paris Time.—The French Government have decided that at the inauguration of the Paris Exposition one uniform time for the whole of France, to be called *l'heure nationale*, will be put in force, instead of the three systems at present in use. It will be communicated electrically from Paris, and will be adopted at all railway and public buildings. Both the French and the foreign hours will be marked at the frontiers.

Exeter Theatre.—Exeter Theatre! What painful reflections these words call up. What oceans of good advice, and heaps of suggestions, were made at the time of the disaster. One of the most practical of these suggestions at any rate will shortly be carried into effect, and the electric light will illuminate in beauty and safety the projected new building in Longbrook-street. A sum will be specially set aside for this purpose

Melbourne.—The alternating plant for 100,000 lights, on the Zipernowski-Deri system, for Melbourne, is being installed by Mr. Charles Flesch, who controls the patents in Australia. He also expects to have a plant of 1,000 arc lights in the coming autumn exhibition. After extended investigation Mr. Flesch has selected the Westinghouse meter as the best in Europe or America, and has given an initial order for 500 meters.

The Hochhausen.—Our old friend, the Hochhausen dynamo, is cropping up again in America, and is being worked by the Excelsior Company of New York. We thought we recognised the old cut of the machine; but what about the description of it?—"The *only* system in the world capable of working arc and incandescent lights on the same circuit successfully!" Pretty good that for Munch—— beg pardon, Hochhausen.

C. and C. Motors.—As many as 300 C. and C. motors are in practical use in New York, distributed in 115 installations. Of these motors 260 are ⅛ h.p., eight of ¼, 19 of ½, six of one, two of two, one of three, and two of five. They are running on the Edison, Brush, and other circuits. They are wound for either arc or incandescent circuits, and

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are used for sorts of small work. Messrs. Shippey Brothers are the agents for Great Britain and France.

Ammeter for Minute Currents.—A galvanometer for the direct measurement of very small currents is shown by Mourlon, of Brussels, at the Brussels Exhibition. It will probably be most useful to medical practitioners in electrical treatment who require to measure currents of a small amount. The instrument indicates directly, and without oscillations, currents from one 1,000th up to one ampere. A resistance of sulphate of zinc and water completes the apparatus, which is handsomely mounted.

New Filaments.—Mr. Shippey has patented a new filament, prepared from semi-metallic material, which he claims is free from the previous patents. Another part of the patent consists in a method employed by him of using up old or damaged filaments. Instead of being useless, as heretofore supposed, Mr. Shippey states that old filaments, being of very pure carbon from the continued action of the current, can be pulverised and remade into filaments, making a better quality of filament than the original.

Hiring Out the Power. — Mr. Spaulding, of the motor department of the Thomson-Houston Company, gives one instance of an electric car company who have an installation of electric power circuits in conjunction with their own tramway system. The company is paying all the running expenses of the road out of the profits of the stationary power system, and has the whole of the income from passengers a clear source of profit to the company. Intending installers of electric roads had better bear this in mind.

Office Lighting.—The electric light is making good headway in London offices. Some thousands of lamps are already in use from isolated plants, and we learn that Messrs. Drake and Gorham, who are responsible for the greater part of these installations, and have made a specialty of this class of work, have recently been entrusted with the lighting of Messrs. Johnson, Budd and Johnson's new offices. The plant will consist of an Otto engine, Elwell-Parker latest type dynamo, and a set of 53·23 L cells made to Drake's and Gorham's specification.

Sawdust Fuel. — An electric light station in Mississippi has a sawmill close to, and experiments have proved so satisfactory in burning sawdust in the boiler furnaces that this form of fuel will be used in future. The sawdust is supplied by a large pipe of galvanised iron, 1ft. in diameter, from the sawmill to the station, and a powerful artificial draught blows the sawdust from one place to the other. The electric light company will be able to supply the sawmill with its power for nothing, in return for which it will get all its fuel gratis.

Toulouse.—Toulouse is to have an installation, where all the circumstances are exceptionally favourable. It has already had for more than a year an installation of about 800 lamps; this is driven by water power, not by gas, as has been sometimes stated. The Theatre du Capitole has a small installation run by gas-engines, but this is distinct from the town lighting, which utilises the water power of the river. The installation is to be increased until 2,000 h.p. is utilised to supply 20 to 25,000 lamps. The conditions are such as to delight the heart of the electrical engineer. The water power is in the centre of the town, permission is obtained to use overhead wires, and the plant will be in use during the whole 24 hours—for a chemical works is to be built in the vicinity, which has arranged to take all the current not required for lighting.

Electric Light for the British Association.—Prof. Ayrton, and other scientific gentlemen, visited Bath on Monday for the purpose of arranging with the secretary of the Local Committee and Mr. Massingham for the practical demonstrations of his lecture on the "Electrical Transmission of Power," to be delivered at the Drill Hall this evening. The experiments will be of the most elaborate kind, and will illustrate the application of electricity to various manufactures, driving different kinds of machinery, welding metals, &c. During the visit of the Association, Mr. Massingham will also illuminate the Sydney Gardens on three nights—including the floral fête fixtures—when there will be a grand display.—The Town Council having resolved to light a portion of the city permanently with electricity, the temporary installation which at first was intended to be laid down, will not be carried out.

Telephonic Improvements in Manchester.—At the close of the meeting of the Lancashire and Cheshire Telephone Company on Wednesday, the shareholders and subscribers and a number of other gentlemen interested in the telephonic system had an opportunity of inspecting the extensive changes which have been made at the new central office of the company in the Royal Exchange. The company, having outgrown the practical capabilities of their old system, have now adopted what is looked upon in the telephonic world as by far the best system extant—the Western Electric Company multiple switch-board. The working of the new system was explained to the visitors by the officials of the company, and illustrations of it were given by the young lady operators, of whom some thirty or forty were seen at work. The process appears somewhat complicated, but the young ladies seem to have mastered it thoroughly, and there was an entire absence of the ringing of bells and the loss of temper which are generally associated with the working of the telephone.

Electricity at the British Association.—The following are among the papers, in connection with electricity, to be read at the Bath meeting. In the Mechanical Section (G): "A Twenty-ton Travelling Crane Worked by Electricity," by Mr. W. Anderson; "Gaseous Fuel,' by Mr. J. E. Dowson; "Light Road Railways," by Mr S. P. W. Sellon; "A New Form of Edison Recorder, and Modern Developments of Graphic Methods," by Prof. N. S. Hele Shaw; "Cowles' Electric Smelting Process," by Mr. R. E. Crompton; "Electric Lighting in America," by Prof. George Forbes; "Electricity as Applied to Mining," by Mr. F. Brain; "Suez Canal Lighting," by Mr. R. P. Sellon; "Edmunds' System of Electrical Distribution from Central Stations," by Mr. N. Edmunds, and "Miners' Electric Safety Lamps," by Mr. N. Watts. A joint discussion with Section A will also take place on "Lightning Conductors." In the Physical Section (A): "On the Heating Effects of Electric Currents," by Mr. W. H. Preece, F.R.S.; "On Measurement of Electrical Wave-Lengths," by Prof. Oliver J. Lodge, F.R.S.; "The Recent Magnetic Survey of Japan," by Dr. C. G. Knott; "On the Transference of Electricity within a Solid Conductor," and "Connection between the Mathematical Theories of Electromagnetic Induction, Viscous Fluid Motion, and Equilibrium and Motion of Elastic Solids," by Sir W. Thomson, F.R.S.

Barnet.—The contract stipulating that Barnet was to be lighted by the 1st of September by electricity—by the 1st Barnet was so lighted. There has been a good deal of discussion about the light, and naturally unusual interest

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is manifested at Barnet itself, where the gas company have incontinently reduced their price from 6s. to 4s. 3d. per thousand; but it is too early for us to describe the installation as it will finally appear. The posts are permanent and some of the wiring, but the delay caused at the beginning with reference to contracts has run the time very short, and at last a temporary engine and a temporary dynamo were brought and the 71 32-c.p. lamps were lighted. The lamps are placed on strong ornamental posts 12ft. in height, fitted with reflectors, by means of which the light is distributed over a large area. The electricity is conducted over the town by about five miles of bare hard-drawn copper wire. Where the wires cross the main thoroughfares, they are laid under ground in creosoted wooden troughs, insulated, and cased in lead tubes. The underground wires pass up through the lamp columns to the globes, and each column is provided with a small door, with an independent switch for each. The dynamo is run at 800 revolutions per minute. The works are at the Hadley end of High Barnet, and the company purpose laying down sufficient machinery for supplying from 1,000 to 5,000 lamps for use in private houses and places of worship.

Telegraphing 4,000 Words a Minute.—Details come from Washington of the system of machine telegraphy perfected by Mr. D. H. Craig, former manager of the Associated Press, who has devoted nineteen years to his system, and claims to be able to telegraph 2,000 words a minute each way, making a total of 4,000 words a minute. The messages are perforated by a little machine, about 8in. by 10in., called a "composer," on which a speed of fifteen to twenty words a minute can easily be obtained. The peculiarity of the machine is that simultaneously with the perforation, the machine prints every word in plain Roman letters like a type-writer. This copy can be retained while the perforated message is sent to the telegraph-office for transmission, with this advantage over ordinary manuscript, that it can be telegraphed at the rate of one to two thousand words a minute instead of the usual twenty or twenty-five of the hand-key system. The machine record is also much more accurate than the "sound" recorder. With the regular office perforator, experts can do 50 words a minute, or 3,000 an hour. The actual cost of transmitting is said to be not over one penny for transmitting 1,000 words a distance of 1,000 miles. The cost of paper to perforate and recording paper is 1½d.; the perforating can be done at the rate of 5d. per 1,000, and the same for type-writing at the receiving end—total, a shilling and a halfpenny for completing 1,000 words. Mr. Craig's apparatus is now on exhibition in a room in the Capitol at Washington.

Alternating Currents Abroad.—The plant for 100,000 lights for Melbourne is supplied by Ganz and Co., of Buda-Pesth. This is an ominous item of information for English electrical engineers. Can the electricians of our mother country not make alternating plants? Or do they not choose to cultivate this species of production for the colonial market? Time was, when any great piece of engineering was to be done in our colonies, or even in nearly all foreign lands, English invention and English enterprise were first in the field for the supply of such undertakings. And now we hear of plants supplied—here, there, everywhere—by Ganz, of Buda-Pesth. No doubt this is a good firm, and have good engineers; and, above all, are almost first in the field on such work. But are our electrical engineers going to stand tamely by and let contracts for important undertakings like this, in English-speaking lands, calmly go to Austrian firms? If a colony, or a foreign government, bethinks itself that such and such a place has water-power in plenty, and that at a certain not too great a distance a town is requiring electric light, to whom in England is it to apply for a contract to satisfactorily carry out such work? The field is great, and promises rich rewards. We are not behindhand in facilities and in organisation. We can carry out railways and build bridges, and now the time comes when we shall be asked to light towns. This is a matter which concerns the engineering credit of England as a whole, and it behoves the engineers of our special branch to make themselves ready for such work, and let people know that they are so ready. We do not want all our colonial towns to be lighted with Austrian plant. We wish them, and all workers in the field, well, but it seems that now for us is the time to be "up and doing," or the rewards of industry will not fall to our lot.

The Cockburn Cut-Outs a Success.—A really good thing when it comes out in the electrical world does not remain long before it becomes a success commercially. At any rate, this is apparently the case with the Cockburn cut-out. We have heard from time to time that Messrs. Cockburn and Day were very busy with their various patterns of cut-outs and switches, but the work has become so thick that they have become cramped in their works at Tabernacle-street, and have had to look out for larger premises where more scope for their inventive and manufacturing genius can be obtained. They have obtained premises of considerable extent at Ferdinand-street, Chalk Farm-road, having three floors of 110ft. in length by 23ft. wide, besides outer premises. These they are rapidly fitting up for carrying on and extending their business, which is spreading its arms into various allied branches of electrical fittings. We are glad to see a young firm put such go and energy into their business, which must eventually bear good fruit. Besides their speciality in cut-outs and switches, Messrs. Cockburn and Day are going in largely for torpedo work, and submarine mining and telegraphy, and other electrical appliances, and have also done a considerable amount of work in a new and compact form of Morse instrument. They have secured the work of making the instruments and fittings for the New Telephone Company, and are doing a considerable amount of work for the colonial and foreign Governments and for the Admiralty. The switches for the Bank of England—quick-break action, mounted on solid serpentine bases—were supplied, through Messrs. Drake and Gorham, by this firm, and a further order is on hand. We understand that the new Ayrton and Perry platinoid spring voltmeter, described at the Society of Telegraph-Engineers' meeting last season, will be manufactured by them.

Animal Electricity.—M. D'Arsonval's experiments, presented to the French Academy of Sciences by M. Brown-Sequard, go to show authoritatively that the contraction of animal muscles is dependent upon the surface electrical tension of the constituent protoplasmic particles. He shows conclusively, by a piece of physical apparatus, that alterations in mechanical tension result in alterations of electrical state; and he explains the nervous contraction of muscle upon the law stated by Lippman, that "the superficial mechanical tension at the surface of separation of two liquids is a function of their difference of potential." M. D'Arsonval's experiment gives a physical conception

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of the muscular fibre. The apparatus consists of an elastic tube of rubber, divided off into a series of compartments by porous discs of wood or pipe-clay, upon which the rubber is firmly fastened. Each compartment contains a layer of mercury, upon which is placed a second layer of acidulated water. Each end of the tube is connected electrically with an indicating apparatus, such as the dead-beat galvanometer of Deprez-D'Arsonval. A weight is suspended at the bottom end. When the apparatus is at rest, no current is manifested; but if the weight be moved up and down, so that the tube assumes successively an elongated and a corrugated form, the galvanometer is traversed by alternating currents, the intensity of which is proportional to the number of compartments in the tube. The law of M. Lippman easily explains the phenomenon. Renvier has shown that the contractile muscle consists, in reality, of superposed layers, alternately liquid and protoplasmic. M. D'Arsonval's experiments explain several hitherto unexplained phenomena, as for instance, why electricity is the greatest excitant of animal muscle, why the nervous excitation is propagated electrically with the speed only of a liquid wave, and explains also, that animal muscle acts as an electric motor rather than a heat motor. The high rate of efficiency will be thus explained, and the heat generated in excessive exertion can be attributed to a waste product analogous to the heating of an electric motor.

The New Court Theatre of Vienna.—The first experimental lighting of the new Hofburg Theatre with electricity, says the *Times*, took place last Thursday week. Parts of the house have been lighted before, but on Aug. 31 for the first time the entire theatre—stage, auditorium, foyers, and corridors—was lighted at full power. Baron Hasenauer, the architect, Mr. T. W. Melhuish, the managing engineer, and M. Emile Sechehaye, the engineer in charge of the theatre, with about half-a-dozen other gentlemen, were the only spectators. The sight was most brilliant, and the architect, who for the first time saw in its glory the house which has taken him 13 years to build, was as much impressed as the rest of the company. The whole lighting is electric, and the arrangement is probably the most complete and substantial ever carried out in any public building. The current will be supplied on the system now known as the battery transformer system. The accumulators are situated in the cellars of the theatre, where the moat of the old Vienna fortifications used to stand, and they are charged from a central station in the Schenkenstrasse, just behind the theatre. The current is conveyed to massive regulating boards, and thence through meters to the distributing room. In this room are placed switches and automatic cut-outs governing the whole of the circuit, and going out to every portion of the house, so that any part of it can be lighted up or put in darkness as required. The total number of lamps in the house is considerably over 5,000, their candle-power varying from 10 to 40. On the stage there are 2,100 lamps of 25 c.p. each. Varied scenic effects in coloured light will be produced by tinted lamps, the coloured chemicals which have hitherto been in use for this purpose being entirely dispensed with. Throughout the house the cables and wires have either been protected by lead coverings or have been laid in wooden grooves, and the insulation of the whole has been repeatedly tested and found most satisfactory. Some changes in the distribution of light will be required before the opening. Thus, the grand staircase —one of the finest pieces of architecture in any theatre—will need more lighting, and some of the lobbies, and particularly the drawing-rooms attached to the imperial boxes, less. But already it may be said that the installation reflects the greatest credit on the company that has set it up, on Mr. H. Lindon, the energetic general inspector of the company, and on Mr. T. W. Melhuish, his very able managing engineer. The theatre is to be opened in the first fortnight in October, but the Emperor has not yet fixed the date.

Eastbourne.—At the half-yearly meeting of the Eastbourne Gas Company, held last Monday, it was decided to lower the price of gas twopence per thousand feet. The directors were unanimous in this decision, but regretted that while they gave to the Corporation a sum equal to twopence per thousand, the Corporation contemplated putting the money received from the Gas Company into the pockets of the Electric Lighting Company. They had hitherto paid £25 a year for each of the arc lights on the parade: the Electric Lighting Company now wanted £35, and the Corporation had decided to split the difference and pay £30. Thus the Gas Company took off twopence per thousand feet of gas, and the Electric Lighting Company put on £5 a year per lamp. He did not think that was quite fair; but it was eminently a ratepayers' question. This lavish outlay for electricity resulted, he thought, in no special benefit to the residents at Old Town, or the people of Meads. He knew many of the inhabitants on the Grand Parade did not like the electric light, and it was his opinion the majority of the visitors did not care a jot about it. He thought the residents on the Grand Parade should find the money, and not the inhabitants generally all over the town. However, he still hoped that the Electric Lighting Company, with the example of the Gas Company before them, would keep pace with the times, and, instead of increasing, would reduce the price of their commodity. He gleaned from a report of the Thomson-Houston electric lighting system, that some four hundred places were being supplied by that system at £22. 10s. per lamp, the light being 1,200 c.p., and the lamps being kept burning all night. Surely, if under that system electric lighting could be carried on at £22. 10s. per lamp, the Eastbourne Electric Lighting Company could supply Eastbourne at £25 a lamp. Taking into account that the lamps were put out early, they were virtually paying at the rate of £60 or £70 a lamp, as compared with the other system, under which the lamps were kept burning all night.—At a meeting of the Eastbourne Town Council it was reported by the Lighting and General Purposes Committee that on August 23rd a letter was read from the secretary to the Eastbourne Electric Light Company, stating that the directors had considered the offer of the Corporation, and come to the conclusion that they cannot supply the parade arc lamps at less than £35 per lamp per annum. It was, therefore, resolved: "That this committee cannot see their way to recommend the council to renew the contract for lighting the parades by the electric light at the rate of £35 per lamp per annum, at the expiration of the present contract, the electric light company having definitely refused the compromise promised by the council."

Richmond.—At the recent half-yearly meeting of the Richmond Gas Company, the chairman, in moving the adoption of the report and balance-sheet, commented upon several items, and then went on to remark that he did not

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think they needed to alarm themselves about a certain matter which had been suggested by the very loud voice of the press—namely, that they would have to look forward to the introduction of electric light into the town. During the past eighteen months they had made a reduction in the price of gas to the amount of 8d. per 1,000 cubic feet. This meant that their total annual charge for gas was about £4,800 less than before. If they could show that they were able to supply gas at 2s. 10d. per 1,000 cubic feet, as they were now doing, he did not think they needed to fear anything with regard to electric light. They had yet to learn that the electric light would be a success. It had not hitherto been so in any place that he knew of. The *Richmond and Kingston Express*, in commenting upon this attitude of the gas company, says: "The chairman of the Richmond Gas Company, at the half-yearly meeting, made the remark that he had yet to learn that the electric light was a success, and that he did not think they need alarm themselves about it. The latter point—that of alarm—he is quite right in, providing only he is ready to march with the times, for gas is constantly extending its usefulness. Gas is not likely to be doomed. But in the manner of obviating this danger he is at sea. Electric light is certainly now in such a position, that to say it is 'nowhere a success' is simply shutting one's eyes to facts. In nearly every country other than England (where a restrictive Act has been till lately in force) towns, and even little villages, in great number have adopted the light and with a successful competition with gas. It is a fact to be borne in mind by the worthy chairman that sweetness and purity, cleanliness and beauty are also paid for in obtaining his rival the electric light, and people, once having tried it, have been known to say that they would willingly pay three or four times the price for the better quality, were that the difference in price. There is this comfort, however, for the company, that they are already themselves in the field for supply of light, and if they are sharp sighted enough, could always keep the ground by undertaking the supply themselves. It is evident that money for maintenance and extension of plant necessary for renewal or maintenance of the gas plant, if applied instead to auxiliary electric lighting, would also bring in dividends if properly worked, and the ground would be kept by the company themselves. This attitude has, we understand, been taken by numerous gas companies in America and also in France; where, for instance, at Marseilles, the public lamps have two services, one of electric light till midnight, and till dawn a feebler single gas jet; the more wealthy customers are also being supplied. There is little doubt this example will be followed by many English gas companies, and Richmond may do the same. Any of the great electrical engineering firms—Crompton's of Chelmsford, the Brush Corporation, of Lambeth, Gulcher's, of Battersea, and others—will be found willing enough to afford free information, and to co-operate with the gas company in keeping their dividends. But if the gas company think they will keep the whole of the lighting still to gas merely by reducing their price, they will be as much mistaken as to expect everyone to drink beer simply because it it is cheaper than wine. *Verbum sap.*"

Electric Heaters.—The principle of electric heating, being based upon the reconversion of electricity, cannot be economical upon any considerable scale under the present conditions of generating electricity. Steam-engines only utilise 10 per cent. of the power of the coal burnt, and a dynamo will only utilise about 80 per cent. of this; so that about six times the amount of heat necessary would have to be generated to that of a stove utilising half the heat of the coal. Yet there are conditions under which electric heaters may be useful. The first is that in which electricity is generated by some agency inexpensive in fuel—such as wind, water, or the kinetic energy of some moving body (a train, for instance, running down hill) which has to be stopped. The other is when a large and economical system of electric distribution is at hand, and small quantities of heat are required, or for short periods of time. In such cases the actual (though still the uneconomical) expenditure of heat may be considerably less that the expenditure of preparing a fire, lighting it, using it, and letting it go out. For heating, then, where costless power is available, and for heating in temporary culinary and other operations, a future may exist for the electric heaters; and a field is also open for the heating of electric cars in winter where the current is already at hand. Dr. W. Leigh Burton, of Richmond, Virginia, has given many years' attention to the subject of electric heaters, having experienced innumerable discouragements and rebuffs, and has at last converted Prof. Houston and Mr. Van Depoele to his ideas of the usefulness of this invention. A general idea of the Burton electric heater may be had by stating that it consisted of an alternate arrangement of obstructing media and free conductors or radiators, arranged in a compact form, and insulated within a fire-proof casing, covered by a metal plate. In this heater the "obstructing media" consisted of platinum wire No. 25, and the "free conductors" of copper blocks one inch and three-quarters long, and half an inch square. The electrical resistance of the first type was low compared with the heater in its present form, owing to the fact that the aggregate length of the obstructing media in the entire coil would only amount to a little over one foot of platinum wire of the size indicated. In May, 1882, the first test was made with the heater with a current from a dynamo machine at Richmond, and here it was demonstrated that the heater "had a future." The copper blocks of the resistance coil were heated to redness by the heat developed in the platinum wire, the dynamo being driven at one-third speed. At another test water was boiled and meat cooked; and taking advantage of the boiling water to cook eggs, these were eaten at the table of the inventor the same evening. A further test of a heater by a dynamo current was made in the spring of 1884, when a ten-light Thomson-Houston dynamo was used, and the heater, having only one-tenth of an ohm resistance, was placed in circuit with the lamps, being probably the first instance in which heat and light were produced from the same current of electricity. Mr. Van Depoele has also had heaters connected on an arc lamp circuit. The proposition of the inventor was to use electric heaters on the railway trains where the use of coke or petroleum stoves has been fraught with such dire results. The power was to be obtained from a dynamo geared to the axle of the cars. The modern instrument consists essentially of a box of sheet iron, strung with resistance wires, and the whole covered with powdered fireclay and securely closed in. Tests made by Lieut. S. Dana Greene showed "that it was possible to warm a car or a room with electricity with a use of current representing in mechanical energy three-fourths of one h.p." The cars of the Richmond Union Electric Railway will be equipped with these heaters, and it would seem that the feasibility of the invention has been established beyond question.

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THE MAGNETIC FIELD.—III.

All the mechanical phenomena here described are illustrations of electro-magnetic phenomena which can be produced by the apparatus shown in Fig. 3. Let S S be a straight wire threaded through an iron ring, B. The ring is not absolutely necessary, as a field is produced also in the air surrounding the wire, but to make the analogy with the box containing water more striking, it is better to represent the field in a somewhat similar form—viz., as contained in a cylindrical iron ring of definite dimensions. Let the ends of the wire be connected with a battery, E, and let there be a key, A, by which the circuit can be closed and opened. The closing of the key corresponds to the putting of the weight on the pan on the right-hand side of Fig. 2, and the opening corresponds to the removal of the weight. The E.M.F. of the battery represents the pull exerted by the weight, and the electrical resistance of the circuit takes the place of the friction of the pulley. Upon closing the key A a current will commence to flow from the positive pole of the battery up to the straight wire, and through the ring from left to right, returning down on the other side to the negative pole of the battery. Just as in the mechanical model the speed of advance of the shaft was gradually increased from zero to its final maximum value, so will now the strength of this current gradually grow until the final value, as defined by Ohm's law, has been attained. This final value does in no way

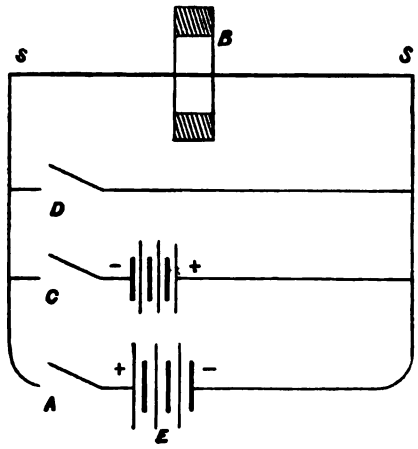

FIG. 3

depend upon the dimensions of the iron ring, B, but is simply the ratio of E.M.F. and resistance. Now let us simultaneously open the key A, and close the key D. This would correspond to the removal of the cord on the right of Fig. 1, and the placing of it on the left, but without the weight. The current will now continue flowing round the circuit S S D in the direction of the hands of a watch, but with gradually diminishing strength, just as in the mechanical model the motion of the shaft was gradually arrested by the friction of the pulley. Now open D, and start the original current again by closing A. When the current has become steady, open A and close C simultaneously. In the circuit of this key we suppose to be inserted a second battery, which tends to produce a current in the wire, S S, in the opposite direction to that of the first battery. The closing of the key C then corresponds to our placing the weight into the pan to the left of Fig. 2, as shown by dotted lines. Just as in the previous case the weight was raised by the inertia of the moving water so storing mechanical energy, so will now electrical energy be stored in the second battery. Suppose this to be a Planté cell, then we would be able at any future time to call forth this energy for working a motor or doing any other kind of work, just as we could utilise the energy of position contained in the raised weight for driving some piece of machinery by allowing the weight to descend again to its original level. We have now, at least for two experiments, shown that there is perfect analogy between the electrical apparatus and the mechanical model we have devised for representing it. There remains yet another experiment—namely, that of rupturing the cord. The rupture was produced by unduly increasing the friction of the pulley. Now, as friction in our model represents the electrical resistance of the circuit in the real apparatus, we have only to unduly increase this resistance in order to produce an effect which corresponds to the breaking of the cord. This can easily be done by simply opening the key A, without closing any of the other keys. By opening this key we increase the resistance of the circuit very nearly to infinity, and the result is a spark, or violent discharge of electricity and rupture of the air between the severed points of the circuit. It will be seen the analogy is perfect also in this respect.

We have in the foregoing only represented the phenomena in a general way without inquiring whether the apparatus was an efficient one. Let us now consider this matter somewhat more in detail. Say the machine represented in Fig. 2 is required for storing potential energy (energy of position as represented by the raised weight, W), how should the details be arranged in order that this object may be attained with the least possible relative loss of energy? The answer is obvious. We must reduce the friction of the pulleys as much as possible, and increase the quantity and velocity of the water in the box; in other words, we must make the box large and the pitch

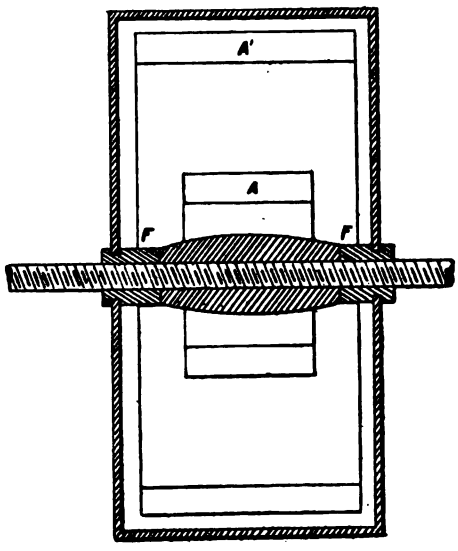

FIG. 4.

of the screw small. By this means we shall reduce the linear velocity of the shaft, and with it the energy lost in friction, whilst at the same time we increase the energy flowing through the whole system, thus raising the coefficient of efficiency. A similar result will also follow from an increase of the weights, for it must be remembered that according to our original assumption the friction depends only on the speed, but not on the pull in the cords. Reasoning from analogy, we can now at once determine the conditions which will make the electrical apparatus efficient. These are in the order corresponding to the above. A low electrical resistance of the circuit, a large mass of iron surrounding the wire, threading the wire many times through the iron ring, and a high E.M.F. of the two batteries. All these conditions, with the exception of the third, are self-evident from analogy; the third, corresponding to the employment of a screw of small pitch, requires some explanation. Now the effect of such a screw is that to a small linear advance of the shaft corresponds a large rotative velocity of the water, or, translated into electrical language, to a small current corresponds a strong magnetic field. We may imagine a strong current to be composed of a number of weak currents flowing side by side. Such a current will produce a strong field, and this result can therefore be obtained by threading the wire, S S, many times through the iron ring; in fact, by making a coil of it.

The foregoing and somewhat lengthy explanation will have shown the reader that our mechanical model can be used to represent a good many electro-magnetic phenomena,

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but still it is not perfect, for it fails to represent one very important phenomenon. We allude to the fact that although a current will always produce a field, a permanent—that is, an unchanging field—does not produce or maintain a current in a wire within the influence of that field. In this respect the model represented in Fig. 2 is at fault, for if by some means we keep the water rotating in the box, there will be a constant tendency to push the screw forward. According to this model, therefore, a permanent field should create an E.M.F. in a wire at rest within the influence of the field, which is contrary to experience. We must consequently alter our model to make it correctly represent this important experimental fact. Fig. 4 shows this new arrangement. It differs from the previous arrangement by the way the feather, F, is fixed. In Fig. 2, the piece to which the feather is attached is a fixture, but in Fig. 4 we replace the fixed support by connections with a second set of paddles, A', contained in the same box as the paddles, A, but set much farther from the centre. As long as the water in the box is quiescent, the paddles, A, will prevent the shaft from rotating almost as completely as if the pieces, F, which carry the feathers engaging into the keyway of the shaft, were fixtures in space, and as we suppose the distance between the two sets of paddles to be considerable, it will be necessary for the inner wheel to revolve some time before motion is communicated to the outer layers of water, and during that time the action of this model will be very similar to that of the model represented by Fig. 2. But let us assume that the whole body of water in the box has been set into uniform rotation by some external means. The two sets of paddles will then revolve with the same angular velocity—that is to say, the screw and its nut will be turned at the same rate, and consequently there will be no advance of the shaft. Our model now illustrates the case of a wire passing through a permanent—that is, unchanging—field, itself remaining at rest, when, as is well known, the field does not produce a current in the wire; just as the whirl of the water within the box does not produce longitudinal motion of the screw shaft.

Now let us see what happens if we accelerate the motion of the water; the outer paddles will be influenced sooner than the inner ones, and overtake them. As we need only consider the relative motion of the two sets of paddles, we may assume the outer paddles to stand still and the inner paddles to turn backwards. To fix ideas, we suppose the motion of the water to be from the observer on the top and towards the observer at the bottom, a direction of the field which in Fig. 2 is produced by moving the shaft to the right. The motion now impressed upon the shaft will therefore be the same as if we prevented it from revolving whilst turning the paddle-wheel, A, in the opposite direction to that in which the water flows. The shaft will now advance to the left. We thus find that an increase in the strength of the field tends to produce a current of opposite direction to that which, acting alone, would produce the same field. Similarly, if we retard the flow of water, the inner paddles will overtake the outer ones, and cause the shaft to advance to the right. Electromagnetically expressed, a diminution of the strength of the field tends to produce a current in such a direction as tends to preserve the original field. These results could also have been deduced from the model shown in Fig. 2, for upon increasing the linear speed of the shaft by applying a heavier weight in the right-hand pan, the screw experiences a resistance equivalent to a thrust to the left corresponding to an E.M.F. acting from right to left, and by removing some of the weight the water would overtake the paddles, and produce an additional thrust on the screw equivalent to an E.M.F. acting from left to right. In either case the change in the strength of the field produced by a change in the current reacts upon the current in such a way as tends to bring it back to its original condition. This fundamental principle is known under the name of its discoverer as Lenz's law. We might, however, have deduced this law, without any reference to our models, simply from the universal principle of the conservation of energy. For if an increase of current were not accompanied by the creation of a counter E.M.F., the additional energy represented by the stronger field could be obtained without a proportional expenditure of energy in some other form, which would be nothing more or less than perpetual motion. Having illustrated the nature of the magnetic field as far as this is possible by mechanical models, which must necessarily always be somewhat crude, we can now proceed to treat the subject in a more rigourously scientific manner without in all cases attempting mechanical illustrations; and we begin by the investigation of the influence of a straight current upon a free magnet pole.

It has already been pointed out that the stream-lines surrounding the wire in a kind of magnetic whirl, tend to propel a free pole in the direction of their flow. As, however, a free magnet-pole is a physical impossibility, there being always two poles of opposite sign in a magnet, this tendency shows itself in a rotation of the magnet, so as to bring its length into a right-angle position to the wire. We imagine the magnet to be the vehicle, or carrier, of its own field, the stream-lines issuing at the north pole, passing through the air, and entering the metal again at the south pole. Let, in Fig. 5, W be the section of the wire carrying a current downwards or from the observer, which we indicate by placing a dot into the circle representing the wire, an upward current being indicated by a small cross—thus, × —and let S be one of the stream-lines belonging to the field of the wire. Let N, C, D, S and N, A, B, S be two of the stream-lines belonging to the field of the magnet, then, from what has been already explained, it will be clear that there will be attraction between the lines S and N, C, and repulsion between the lines S and N, A. These forces produce a couple tending to turn the magnet round O, as a fixed centre, in a counter clockwise direction.

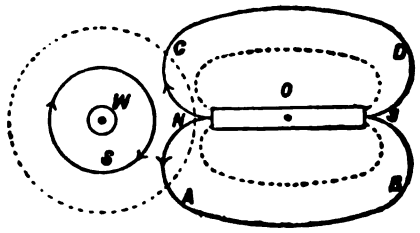

FIG. 5.

Similarly, all the stream-lines, S, which lie to the left of the stream-lines N, C, and N, A, must produce the same result, whilst all the stream-lines of the magnet to the right of S will also tend to turn the latter in a counter clockwise direction. Those stream-lines of wire and magnet which cut each other will tend to produce the opposite effect, but as their density decreases with an increase of distance from the pole and from the wire, the differential effect of all the lines will still be in the sense of producing a counter clockwise rotation of the magnet. This theory is confirmed by actual experiment. The magnet, if free to follow the influence of the field of the wire, sets itself so that its axis forms a tangent to a circle drawn round the wire as centre. Expressed in other words, the current produces on the pole a force at right angles to the plane laid through the wire conveying the current and the pole.

THE BRITISH ASSOCIATION.

ADDRESS TO THE MECHANICAL SCIENCE SECTION BY WILLIAM HENRY PREECE, F.R.S., M.I.C.E., ETC., PRESIDENT OF THE SECTION.

"Canst thou send lightnings, that they may go and say unto thee, Here we are?" were pregnant words addressed to Job unknown centuries ago. They express the first recorded idea in history of the potentiality of electricity to minister to the wants of mankind. From Job to Franklin is a long swing in the pendulum of time. It was not until that American philosopher brought down atmospheric electricity by his kite-string in 1747, and showed that we could lead it where we willed, that we were able to answer the question addressed to the ancient patriarch. Nearly another century elapsed before this mysterious power of Nature was fairly conquered. It has been during this generation, and during the life of the British Association,

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that electricity has been usefully employed; and it is because I have taken a subordinate position in inaugurating nearly all of its practical applications, that I venture to make the developments of them the text of my address to this section.

People are singularly callous in matters affecting their own personal safety; they will not believe in mysteries, and they ridicule or condemn that which they do not understand. The Church itself set its face against Franklin's "impious" theories, and he was laughed to scorn by Europe's scientific sons; and even now, though commissions composed of the ablest men of the land have sat and reported on Franklin's work in England, France, and nearly every civilised nation, the public generally remains not only ignorant of the use of lightning conductors, but absolutely indifferent to their erection, and, if erected, certainly careless of their proper maintenance. I found in a church not very far from here the conductor leaded into a tombstone, and in a neighbouring cathedral the conductor only a few inches in the ground, so that I could draw it out with my hand. Although I called the attention of the proper authorities to the absolute danger of the state of affairs, they remained in the same condition for years.

Wren's beautiful steeple in Fleet-street (St. Bride's) was well-nigh destroyed by lightning in 1764. A lightning rod was fixed, but so imperfectly that it was again struck. In July last (1887) it was damaged because the conductor had been neglected, and had lost its efficiency.

As long as points remain points, as long as conductors remain conductors, as long as the rods make proper connection with the earth, lightning protectors will protect; but if points are allowed to be fused or to corrode away, as long as bad joints or faulty connections are allowed to remain, as long as bad earths or no earths exist, so long will protectors cease to protect, and they will become absolute sources of danger. Lightning conductors, if properly erected, duly maintained, and periodically inspected, are an absolute source of safety; but if erected by the village blacksmith, maintained by the economical churchwarden, and never inspected at all, a loud report will some day be heard, and the beautiful steeple will convert the churchyard into a new geological formation.

We have not yet acquired that mental confidence in the accuracy of the laws that guide our procedure in protecting buildings from the effects of atmospheric electrical discharges which characterises most of the practical applications of electricity. Some of our cherished principles have only very recently received a rough shaking from the lips of Prof. Oliver Lodge, F.R.S., who, however, has supported his brilliant experiments by rather fanciful speculation, and whose revolutionary conclusions are scarcely the logical deduction from his novel premisses. The whole subject is going to be thoroughly discussed at this meeting.

We are now obtaining much valuable information about the nature of lightning from photography. We learn that it does not, as a rule, take that zigzag course conventionally used to represent a flash on canvas. Its course is much more erratic and sinuous, its construction more complicated, and pictures have been obtained of *dark* flashes whose *raison d'être* has not yet been satisfactorily accounted for. The network of telegraph wires all over the country is peculiarly subject to the effects of atmospheric electricity, but we have completely mastered the vagaries of lightning discharge in our apparatus and cables. Accidents are now very few and far between.

The art of transmitting intelligence to a distance beyond the reach of the ear and the eye, by the instantaneous effects of electricity, had been the dream of the philosopher for nearly a century, when, in 1837, it was rendered a practical success by the commercial and far-sighted energy of Cooke, and the scientific knowledge and inventive genius of Wheatstone. The metallic arc of Galvani (1790) and the developments of Volta (1796) had been so far improved that currents could be generated of any strength, the law of Ohm (1828) had shown how they could be transmitted to any distances, the deflection of the magnetic needle by Oersted in 1819, and the formation of an electro-magnet by Ampère and Sturgeon, and the attraction of its armature had indicated how those currents could be rendered visible as well as audible.

Cooke and Wheatstone in 1837 utilised the deflection of the needle to the right and to the left to form an alphabet. Morse used the attraction of the armature of an electro-magnet to raise a metal style to impress or emboss moving paper with visible dots and dashes. Steinheil imprinted dots in ink on the different sides of a line on paper, and also struck two bells of different sound to affect the ear. Bréguet reproduced in miniature the actual movements of the semaphore then so much in use in France; while others rendered practical the favourite idea of moving an indicator around a dial, on which the alphabet and the numerals were printed, and causing it to dwell against the symbol to be read—the A, B, C instrument of Wheatstone in England and of Siemens in Germany. Wheatstone conceived the notion of printing the actual letters of the alphabet in bold Roman type on paper—a plan which was made a perfect success by Hughes in 1854.

At the present moment the needle system of Cooke and Wheatstone, as well as the A, B, C dial telegraph, are very largely used in England on our railways and in our smaller post-offices. The Morse recorder and the Hughes type-printer are universally used on the Continent; while in America the dot and dash alphabet of Morse is impressed on the consciousness through the ear by the sound of the moving armature striking against the stops that limits its motion. In our larger and busier offices the Morse sounder and the bell system, as perfected by Bright, are very largely used, while the Press of this country is supplied with news which is recorded on paper by ink dots and dashes at a speed that is almost fabulous.

Sir William Thomson's mirror—the most delicate form of the needle system—where the vibratory motions of an imponderable ray of light convey words to the reader, and his recorder, where the wavy motion of a line of ink spirted on paper by the frictionless repulsion of electricity performs the same function, are exclusively employed on our long submarine cables.

Bakewell, in 1848, showed how it was possible to reproduce facsimiles of handwriting and of drawing at a distance, and in 1879 E. A. Cowper reproduced one's own handwriting, the moving pen at one station so controlling the currents flowing on the line wire that they caused a similar pen to make similar motions at the other distant station. Neither of these plans, the former beautifully developed by Caselli and d'Arlincourt, and the latter improved by Robertson and Elisha Gray, have yet reached the practical stage.

The perfection of telegraphy has been attained by that chief marvel of this electrical age—the speaking telephone of Graham Bell. The reproduction of the human voice at a distance, restricted only by geographical limits, seems to have reached the confines of human ingenuity; and though wild enthusiasts have dreamt of reproducing objects abroad visible to the naked eye at home, no one at the present moment can say that such a thing is possible, while in the face of the wonders that have been done no one dare say that it is impossible.

The commercial business of telegraphy, when our thoughts and wishes, orders and wants, could be transmitted for money, was inaugurated in this country by the establishment of the Electric Telegraph Company in 1846, and until 1870 it remained in the hands of private enterprise, when it was purchased by the Government, and placed under the sole control of the Postmaster-General. It has been the fashion to decry the terms of purchase of the various undertakings then at work by those who have not understood the question, and by those who, being politically opposed to the Government in power at the time, saw all their acts, not only through a glass darkly, but through a reversing lens. A business producing £550,000 per annum was bought at twenty years' purchase, and that business has now increased to £2,000,000 per annum. Six million messages per annum have increased to 52,000,000.

Every post office has been made a telegraph office, every village of any size has its wire; messages which used to cost 12s. 6d. are now sent for 6d.; a tariff which was vexatious from its unfair variation is now uniform over the United Kingdom, and no one can justly complain of error or delay in the transmission of their messages. Silly complaints are sometimes inserted in the press of errors which the most elementary knowledge of the Morse alphabet would detect, and little credit is given to the fact that the most perfect

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telegraph is subject to strange disturbances from terrestrial and atmospheric causes which admit sources of error beyond the control of the telegraphist. A flash of lightning in America may cause an extra dot in Europe, and *man* may become *war*. An earthquake in Japan may send a dash through France, and *life* would become *wife*. A wild goose flying against a telegraph wire might drive it into momentary contact with another wire, and *sight* might become *night*. Everyone should know his Morse alphabet, and people should learn how to write—nine-tenths of the errors made are due to the execrable caligraphy of the present day. As a matter of fact, in ninety-nine cases out of a hundred, the telegraphist delivers to the editor of a newspaper "copy" far more accurate than the first proof of his own leader submitted by the printer. The quantity of news transmitted is enormous, an average of 1,538,270 words are delivered per day. The recent convention in Chicago, when the Republican party of the United States nominated their candidate for the presidentship, created so much business that every American paper has chronicled this big thing as unique; 500,000 words were sent on one night, but we in England, when Mr. Gladstone introduced his celebrated Home Rule Bill on April 8, 1886, sent from the Central Telegraph Office in London 1,500,000 words.

The growth of business has led to vast improvement in the carrying capacity of the wires. Cooke and Wheatstone required five wires for the first needle instrument to work at the rate of four words per minute. One wire can now convey six messages at ten times the speed. The first Morse apparatus could work at about five words a minute; we now transmit news at the rate of 600 words a minute. In 1875 it was thought wonderful to transmit messages to Ireland at 80 words a minute. When I was recently at Belfast I timed messages coming at the rate of 461 words a minute. Duplex working—that is, two messages travelling on the same wire at the same time in opposite directions, the invention of Gintl, of Vienna—is now the normal mode of working; Edison's quadruplex is common; and the Delany system of multiplex working is gradually being introduced, by which six messages are indiscriminately sent in either direction. The telegraphic system of England has been brought to the highest pitch of perfection. We have neither neglected the inventions of other countries, nor have we been chary of exercising inventive skill ourselves, and we have received our full meed of that reward which is always freely bestowed on a British Government official, neglect and abuse. All parts of the civilised world are now united by submarine cables. The *Times* every morning has despatches from every quarter of the globe, giving the news of the previous day; 110,000 miles of cable have been laid by British ships, and nearly £40,000,000 of British capital has been expended by private enterprise in completing this grand undertaking. A fleet of 37 ships is maintained in various oceans to lay new cables and to repair breaks and faults as they occur—faults that arise, among other causes, from chafing on coral reefs, ships' anchors, the onslaught of insects, and earthquakes. The two cables connecting Australia and Java were recently simultaneously broken by an earthquake.

The politician, unmindful of the works of the engineer, is apt to apply to the credit of his own proceedings the growing prosperity of the world. The engineer, however, feels that steam and electricity in his hands have done more to economise labour, to cheapen life, to increase wealth, to promote international friendship, to alleviate suffering, to ward off war, to encourage peace, than all the legislation and all the verbosity of the politician.

The railways of this country are entirely dependent for the conduct of their traffic on the telegraph, and the security of their passengers is mainly due to the working of the block system. A railway, say, between London and Bath, is broken up into certain short sections, and only one train is allowed on one section at one time. The presence, motion, and departure of trains is announced and controlled by electric signals, and the out-door signals are governed by these electric signals. There are few more interesting places to visit than a well-equipped signal-box on one of our main railways. The signalman is able to survey the lines all around and about him by aid of his electric signals. He can talk by telegraph or by telephone to his neighbours and his station-master; he learns of the motion of the trains he is marshalling by the different sounds of electric bells; he controls his out-door signals by the deflection of needles or the movement of miniature semaphores; he learns the true working of his distant signals by their electrical repetition; machinery governs and locks every motion he makes so that he cannot make a mistake. The safety of railway travelling is indicated by the fact that while in the five years ending 1878 thirty-five people were killed annually from causes beyond their own control, in the five years ending 1887 the average has been reduced to sixteen. One person is killed in 35,000,000 journeys made by train. Wherever we are dependent on human agency we are subject to human error, and a serious accident very recently at Hampton has shown how the most perfect machinery may be rendered valueless to protect life when perversity, thoughtlessness, or criminality enter as factors into the case.

At the meeting of the Association in Plymouth in 1877 I was able for the first time in this country to show the telephone at work. Since then its use has advanced with giant strides. There are probably a million instruments at work now throughout the civilised world. Its development has been regularly chronicled at our meetings. As far as the receiving part of the apparatus is concerned, it remains precisely the same as that which I brought over from America in 1877; but the transmitter, ever since the discovery of the microphone by Hughes in 1878, has been entirely remodelled. Edison's carbon transmitter was a great step in advance; but the modern transmitters of Moseley, Berliner, D'Arsonval, De Jongh, leave little to be desired. The disturbances due to induction have been entirely eliminated, and the laws regulating the distance to which speech is possible are so well known, that the specification of the circuit required to connect the Land's End with John O'Groat's by telephone is a simple question of calculation. A circuit has been erected between Paris and Marseilles, 600 miles apart, with two copper wires of 6½ gauge, weighing 540lb. per mile, and conversation is easily maintained between those important cities at the cost of three francs for three minutes. One scarcely knows which fact is the more astounding—the distance at which the human voice can be reproduced, or the ridiculously simple apparatus that performs the reproduction. But more marvellous than either is the extreme sensitiveness of the instrument itself, for the energy contained in one heat unit (gramme-water-degree) would, according to Pellat, maintain a continuous sound for 10,000 years.

The influence which electric currents exert on neighbouring wire extends to enormous distances, and communication between trains, and ships in motion, between armies inside and outside besieged cities, between islands and the mainland, has become possible without the aid of wires at all, by the induction which is exerted through space itself. On the Lehigh Valley Railway, in the United States, such a system of telegraphing without wires is in actual daily use.

The conduct of telephonic business in England is still in the hands of those who hold the patents, and who maintain a most rigid monopoly. These patents have only a short period to run, and when they expire we may expect to find that England will not occupy the very retired position she holds now as a telephone country. Stockholm has more subscribers than London; there are 15,000 subscribers in and about New York, while the number in London is only 4,851.

Electric lighting has become popular, not alone from the beauty of the light itself, but from its great hygienic qualities in maintaining the purity and coolness of the air we breathe. The electric light need not be more brilliant than gas; but it must be more healthy. It need not be cooler than a wax candle; but it must be brighter, steadier, and more pleasant to the eye. In fact, it can be rendered the most perfect artificial illuminant at our disposal, for it can illumine a room without being seen directly by the eye; it can be made absolutely steady and uniform without irritating the retina; it does not poison the air by carbonic acid and carbonic oxide, or dirty the decorations by depositing unconsumed carbon; it does not destroy books or articles of vertu and art by forming water which absorbs sulphur acids; and it does not unnecessarily heat the room.

(*To be continued.*)

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

THE PRESIDENTIAL ADDRESS.

It is customary for the majority of technical papers to report almost, or quite verbatim, the presidential address as delivered each succeeding year at the meeting of the British Association, and, for the matter of that, most of the ordinary political papers go and do likewise. With all due deference to the transcendental scientific attainments of the various presidents, it may be taken as almost capable of proof that these addresses are printed because it is the fashion so to do, and not because the responsible authorities believe for a moment they are valuable. It has been our lot to try to hear and attempt to read many of these lucubrations, but the former has generally ended in failure and the latter in despair. Only a moderate number can comfortably hear the sound of the human voice, and when twice that number attempt to do so one half usually and naturally fail in their endeavour. With regard to reading through a long address, life is too short. The average man, who must be able to throw in a remark during a casual conversation, depends upon similar casual remarks he may hear, or upon the trebly concentrated essence of the address given by some newspaper. Catch phrases soon obtain a footing, and these satisfy the ordinary man, and especially the supporters of the association whose *ultima Thule* is the number of garden parties, conversaziones, and excursions that can be crammed into the week's athletics. We follow the fashion and go with the stream simply because it is easier to pull with the tide than against it. But though we believe that Sir Frederick Bramwell's address will go the way of all such addresses, it has certain conspicuous peculiarities that must remove it from the realms of commonplace. In the first place, if one may contradict ourselves, to venture upon an Irishism, it is commonplace—commonplace enough to be understanded of the multitude. It is an *olla podrida*, each constituent of which directly appeals to a different class. It sets no one's back up, except maybe in the reference to the Channel tunnel. Simple truths are too often forgotten in the endeavour to pose before an expectant world as the exponent of some recondite scientific speculation, which is understood by not half-a-dozen beings in the universe, and which raises the criticisms of wonder at the "creature's knowledge," which really is another way of condoning our own ignorance or cowardice to make believe that we understand things utterly beyond our comprehension. "What in the name of goodness is he driving at"? is a question which frequently flashes through the minds of those who listen to papers and discussions, but finds no voice because the thinker is fearful of showing his ignorance.

To return, however, to Sir Frederick Bramwell's address, the text of which is "Next-to-nothing"; the same may be said of this article—sketchy, discursive,

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rambling, inane, are the adjectives applied, yet no one denies the correctness of what is said. Perhaps the sentences most pregnant with food for thought are those referring to Watt. It is said: "To Watt, also, we owe that great source of economic working, the knowledge of the expansive force of steam; and to his prescience we owe the steam jacket, without which expansion, beyond certain limits, is practically worthless. I have said 'prescience'—foreknowledge—but I feel inclined to say that, in this case, prescience may be rendered 'pre-science,' for I think that Watt felt the utility of the steam jacket, without being able to say on what ground that utility was based." It is the opinion of a great many people that the so-called scientific men—the writers of papers of the intellectual gymnastic kind, the wielders of pepper boxes filled with algebraic symbols—are a little too arrogant in their tones when they endeavour to maintain that they are the salt of the earth, and that, without them, progress would stand still "like Joshua's moon in Ajalon." Men not filled to the brim with this kind of science sometimes *feel* that something is wanted, and straightway proceed to invent that something. The major portion of inventors whose works are of a practical character have little knowledge of the higher flights of science, and are frequently very weak as regards the rudiments. They, however, show what can be done, and subsequently the mathematicians demonstrate it can be done, and why it can be done. Greater credit is due to those who feel rather than know, even though they may not be Watts. Of our own particular branch of science and its applications the President does not say much, though he may think the more, for what reference there is comes in the forefront of the address. It is quite true there is "no branch of science towards which the public looks with greater hope of practical benefits" than to electricity, and when we contemplate the progress that has been made in this direction since the last meeting of the Association at Bath seventy-four years ago, it cannot be denied that such looking is justified and justifiable. In '64 the telephone and microphone, electric light and electric traction were things to come, now they are realities; the speed of telegraphing then was tame in comparison with what it is now; submarine telegraphy practically was not—its failures had been many, but now, like Crusoe's lordship, from this island as centre to the uttermost parts of the earth its ramifications may be traced, its success has been constant, its value to humanity incalculable.

There is no reason to suppose that the rate of progress will diminish, and it may be found that electricity is destined to play no inconsiderable part in the realisation of the President's prophecy that at the centenary of the Association in 1931 steam will have been relegated to the museums. It is not that in its present applications electricity provides a prime motor, but that, notwithstanding Lord Rayleigh's demonstration to the contrary, men's minds are tending towards the direct conversion of heat into electricity. That this is economically impossible remains to be proved, and it remains a subject for the discussion of future generations of members of the British Association.

CORRESPONDENCE.

FLATS ON THE COMMUTATOR.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—In your last week's selection of "Leaves from the Diary of a Young Electrician," I observe that the author attributes "flats" on the commutator to softness of the segments on which the flat occurs.

I have found that almost invariably this is due to a defective connection of those segments to the armature, producing, by the resistance it introduces, a greater difference of potential across that particular section than its proper share of the total; the remedy being resoldering of the connections. Of course, when the flat has once begun, the jumping of the brushes aggravates the evil, but bad connection will usually be found to be the primary cause.—Yours, &c.,

T. M. WINSTANLEY WALLIS.

Derby, September 3, 1888.

THE BRITISH ASSOCIATION AT BATH.

The 58th annual meeting of the British Association was opened on Wednesday at Bath. The retiring president, Sir Henry Roscoe, after alluding to the previous meeting at Bath, in 1864, which was presided over by Sir Chas. Lyell, "of beloved and venerated memory," representing the domains of pure science, introduced Sir Frederick Bramwell as the exponent of applied science. Sir F. Bramwell then took the chair amid loud cheers, and delivered the following address:

PRESIDENTIAL ADDRESS BY SIR FREDERICK BRAMWELL, D.C.L., F.R.S., M.I.C.E.

The late Lord Iddesleigh delighted an audience for a whole evening by an address on "Nothing." Would that I had his talents, and could discourse to you as charmingly as he did to his audience, but I dare not try to talk about "Nothing." I do, however, propose, as one of the two sections of my address, to discourse to you on the importance of the "Next-to-Nothing.' The other section is far removed from this microscopic quantity, as it will embrace the "Eulogy of the Civil Engineer," and will point out the value to science of his works.

I do not intend to follow any system in dealing with these two sections. I shall not even do as Mr. Dick, in "David Copperfield" did—have two papers, to one of which it was suggested he should confine his Memorial and his observations as to King Charles's head. The result is, you will find, that the importance of the next-to-nothing, and the laudation of the civil engineer, will be mixed up in the most illogical and haphazard way throughout my address. I will leave to such of you as are of orderly minds the task of rearranging the subjects as you see fit, but I trust—arrangement or no arrangement—that by the time I have brought my address to a conclusion, I shall have convinced you that there is no man who more thoroughly appreciates the high importance of the "next-to-nothing" than the civil engineer of the present day, the object of my eulogy this evening.

If I may be allowed to express the scheme of this address in modern musical language, I will say that the "next-to-nothing" "motive" will commonly usher in the "praise-song" of the civil engineer; and it seems to me will do this very fitly, for in many cases it is by the patient and discriminating attention paid to the effect of the "next-to-nothing" that the civil engineer of the present day has achieved some of the labours of which I now wish to speak to you.

An association for the advancement of science is necessarily one of such broad scope in its objects, and is so thoroughly catholic as regards science, that the only possible way in which

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it can carry out those objects at all is to segregate its members into various subsidiary bodies, or sections, engaged on particular branches of science. Even when this division is resorted to, it is a hardy thing to say that every conceivable scientific subject can be dealt with by the eight sections of the British Association. Nevertheless, as we know, for fifty-seven years the Association has carried on its labours under sections, and has earned the right to say that it has done good service to all branches of science.

Composed, as the Association is, of a union of separate sections, it is only right and according to the fitness of things that, as time goes on, your presidents should be selected, in some sort of rotation, from the various sections. This year it was felt by the council and the members that the time had once more arrived when Section G—the mechanical section—might put forward its claim to be represented in the presidency; the last time on which a purely engineering member filled the chair having been at Bristol in 1875, when that position was occupied by Sir John Hawkshaw. It is true that at Southampton, in 1882, our lamented friend, Sir William Siemens, was president, and it is also true that he was a most thorough engineer and representative of Section G; but all who knew his great scientific attainments will probably agree that, on that occasion, it was rather the Physical Section A which was represented, than the Mechanical Section G.

I am aware, it is said, Section G does not contribute much to pure science by original research, but that it devotes itself more to the application of science. There may be some foundation for this assertion, but I cannot refrain from the observation, that when engineers, such as Siemens, Rankine, Sir William Thomson, Fairbairn, or Armstrong make a scientific discovery, Section A says it is made, not in the capacity of an engineer, and therefore does not appertain to Section G, but in the capacity of a physicist, and therefore appertains to Section A—an illustration of the danger of a man's filling two positions, of which the composite prince-bishop is the well-known type. But I am not careful to labour this point, or even to dispute that Section G does not do much for *original* research. I don't agree it is a fact, but, for the purposes of this evening, I will concede it to be so. But what then? This Association is for the "advancement of science"—the *advancement*, be it remembered; and I wish to point out to you, and I trust I shall succeed in establishing, that for the *advancement* of science it is absolutely necessary there should be the *application* of science, and that, therefore, the section, which as much as any other (or, to state the fact more truly, which more than any other) in the Association *applies* science, is doing a very large share of the work of *advancing* science, and is fully entitled to be periodically represented in the presidency of the whole Association.

I trust also I shall prove to you that applications of science, and discoveries in pure science, act and re-act the one upon the other. I hope in this to carry the bulk of my audience with me, although there are some, I know, whose feelings, from a false notion of respect for science, would probably find vent in the "toast" which one has heard in another place—this "toast" being attributed to the pure scientist—"Here's to the latest scientific discovery: may it never do any good to anybody!"

To give an early illustration of this action and reaction, which I contend occurs, take the well-worn story of Galileo, Torricelli, and the pump-maker. It is recorded that Galileo first, and his pupil Torricelli afterwards, were led to investigate the question of atmospheric pressure by observing the failure of a pump to raise water by "suction" above a certain level. Perhaps you will say the pump-maker was not applying science, but was working without science. I answer, he was unknowingly applying it, and it was from that which arose in this unconscious application that the mind of the pure scientist was led to investigate the subject, and thereupon to discover the primary fact, of the pressure of the atmosphere, and the subsidiary facts which attend thereon. It may appear to many of you that the question of the exercise of pressure by the atmosphere should have been so very obvious, but little merit ought to have accrued to the discoverer; and that the statement, once made, must have been accepted almost as a mere truism. This was, however, by no means the case. Sir Kenelm Digby, in his "Treatise on the Nature of Bodies," printed in 1658, disputes the proposition altogether, and says, in effect, he is quite sure, the failure of the pump to raise water was due to imperfect workmanship of some kind or description, and had nothing to do with the pressure of the air, and there is no reason why a pump should not suck up water to any height. He cites the boy's sucker, which, when applied to a smooth stone, will lift it, and he says the reason why the stone follows the sucker is this. Each body must have some other body in contact with it. Now, the stone being in contact with the sucker, there is no reason why that contact should be broken up, for the mere purpose of substituting the contact of another body, such as the air. It seems pretty clear, therefore, that even to an acute and well-trained mind, such as that of Sir Kenelm Digby, it was by no means a truism, and to be forthwith accepted when once stated, that the rise of water on the "suction side" of a pump was due to atmospheric pressure. I hardly need point out that the pump-maker should have been a member of "G." Galileo and Torricelli, led to reflect by what they saw, should have been members of "A" of the then "Association for the Advancement of Science."

But passing away from the question of the value of the application of science of a date some two and a half centuries ago, let us come a little nearer to our own times.

Electricity—known in its simplest form to the Greeks by the results arising from the friction on amber, and named therefrom; afterwards produced from glass-cylinder machines, or from plate machines; and produced a century ago by the "Influence" machine—remained, as did the discoveries of Volta and Galvani, the pursuit of but a few, and even the brilliant experiments of Davy did not suffice to give very great impetus to this branch of physical science.

Ronalds, in 1823, constructed an electric telegraph. In 1837 the first commercial use was made of the telegraph, and from that time electrical science received an impulse such as it had never before experienced. Further scientific facts were discovered; fresh applications were made of these discoveries. These fresh applications led to renewed vigour in research, and there was the action and reaction of which I have spoken. In the year 1871 the Society of Telegraph-Engineers was established. In the year 1861 our own Association had appointed a committee to settle the question of electrical standards of resistance, which committee, with enlarged functions, continued its labours for twenty years, and of this committee I had the honour of being a member. The results of the labours of that committee endure (somewhat modified, it is true), and may be pointed to as one of the evidences of the value of the work done by the British Association. Since Ronald's time, how vast are the advances which have been made in electrical communication of intelligence by land lines, by submarine cables all over the world, and by the telephone! Few will be prepared to deny the statement that pure electrical science has received an enormous impulse, and has been advanced by the commercial application of electricity to the foregoing and to purposes of lighting. Since this latter application, scores, I may say hundreds, of acute minds have been devoted to electrical science, stimulated thereto by the possibilities and probabilities of this application.

In this country, no doubt, still more would have been done if the lighting of districts from a central source of electricity had not been since 1882 practically forbidden by the Act passed in that year. This Act had in its title the facetious statement that it was "to facilitate electrical lighting"—although it is an Act which, even modified as it has been this year, is still a great discouragement of free enterprise and a bar to progress. The other day a member of the House of Commons was saying to me: "I think it is very much to our discredit in England that we should have allowed ourselves to be outrun in the distribution of electric lighting to houses by the inhabitants of the United States, and by those of other countries." Looking upon him as being one of the authors of the "facetious" Act, I thought it pertinent to quote the case of the French parricide, who, being asked what he has to say in mitigation of punishment, pleads, "Pity a poor orphan"—the parricide and the legislator being both of them authors of conditions of things which they affect to deplore. I will say no more on this subject, for I feel that it would not be right to take advantage of my position here to-night to urge political economy views, which should be reserved for Section F. I will merely, and as illustrative of my views of the value of the application of science to science itself, say there is no branch of physics pursued with more zeal and with more happy results than that of electricity, with its allies, and there is no branch of science towards which the public looks with greater hope of practical benefits—a hope that, I doubt not, will be strengthened after we have had the advantage of hearing one of the ablest followers of that science, Prof. Ayrton, who on Friday next has been good enough to promise to discourse on "The Electrical Transmission of Power."

One of the subjects which, as much as (or probably more than) any other, occupies the attention of the engineer, and therefore of Section G, is that of (the so-called) prime movers; and I will say boldly that, since the introduction of printing by the use of movable type, nothing has done so much for civilisation as the development of these machines. Let us consider these prime movers; and, first, in the comparatively humble function of replacing that labour which might be performed by the muscular exertions of human beings—a function which at one time was looked upon by many kindly but short-sighted men as taking the bread out of the mouth of the labourer (as it was called), and as being, therefore, undesirable. I remember revisiting my old schoolmaster, and his saying to me, shaking his head: "So you have gone the way I always feared you would, and are making things of iron and brass to do the work of men's hands."

It must be agreed that all honest and useful labour is honourable; but when that labour can be carried out without the exercise of any intelligence, one cannot help feeling that the result is likely to be intellectually lowering. Thus it is a sorry thing to see unintelligent labour, even although that

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labour be useful. It is but one remove from unintelligent labour which is not useful; that kind of labour generally appointed (by means of the tread-wheel or the crank) as a punishment for crime. Consider even the honourable labour (for it is useful and it is honest) of the man who earns his livelihood by turning the handle of a crane, and compare this with the labour of a smith, who, while probably developing more energy by the use of his muscles than is developed by the man turning the crane-handle, exercises at the same time the powers of judgment, of eye, and of hand in a manner which I never see without my admiration being excited. I say that the introduction of prime movers as a mere substitute for unintelligent manual labour is in itself a great aid to civilisation and to the raising of humanity, by rendering it very difficult, if not impossible, for a human being to obtain a livelihood by unintelligent work—the work of the horse in the mill, or of the turnspit.

But there are prime movers and prime movers—those of small dimensions, and employed for purposes where animal power or human power might be substituted, and those which attain ends that by no conceivable possibility could be attained at all by the exertion of muscular power.

Compare a galley—a vessel propelled by oars—with the modern Atlantic liner; and, first, let us assume that prime movers are non-existent, and that this vessel is to be propelled galley-fashion. Take her length as some 600ft., and assume that place be found for as many as 400 oars on each side, each oar worked by three men, or 2,400 men; and allow that six men, under these conditions, could develop work equal to 1 h.p.—we should have 400 h.p. Double the number of men, and we should have 800 h.p., with 4,800 men at work, and at least the same number in reserve, if the journey is to be carried on continuously. Contrast the puny result thus obtained with the 19,500 h.p. given forth by a large prime mover of the present day, such a power requiring, on the above mode of calculation, 117,000 men at work and 117,000 in reserve; and these to be carried in a vessel less than 600 feet in length. Even if it were possible to carry this number of men in such a vessel, by no conceivable means could their power be utilised so as to impart to it a speed of twenty knots an hour, weighing, as it would, some 10,500 tons gross.

This illustrates how a prime mover may not only be a mere substitute for muscular work, but may afford the means of attaining an end that could not by any possibility be attained by muscular exertion, no matter what money was expended, or what galley-slave suffering was inflicted.

Take, again, the case of a railway locomotive. From 400 to 600 h.p. developed in an implement which, even including its tender, does not occupy an area of more than fifty square yards, and that draws us at sixty miles an hour. Here, again, the prime mover succeeds in doing that which no expenditure of money or of life could enable us to obtain from muscular effort.

To what, and to whom, are these meritorious prime movers due? I answer: to the application of science, and to the labours of the civil engineer, using that term in its full and proper sense, as embracing all engineering other than military. I am, as you know, a civil engineer, and I desire to laud my profession and to magnify mine office; and I know of no better means of doing this than by quoting to you the definition of "civil engineering," given in the charter of the Institution of Civil Engineers—namely, that it is "the art of directing the great sources of power in Nature for the use and convenience of man." These words are taken from a definition or description of engineering given by one of our earliest scientific writers on the subject, Thomas Tredgold, who commences that description by the words above quoted, and who, having given various illustrations of the civil engineer's pursuits, introduces this pregnant sentence:

"This is, however, only a brief sketch of the objects of civil engineering, the real extent to which it may be applied is limited only by the progress of science; its scope and utility will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical art, since its bounds are unlimited, and equally so must be the researches of its professors."

"The art of directing the great sources of power in Nature for the use and convenience of man." Among all secular pursuits can there be imagined one more vast in its scope, more beneficent, and therefore more honourable, than this? There are those, I know—hundreds, thousands—who say that such pursuits are not to be named as on a par with those of literature; that there is nothing ennobling in them; nothing elevating; that they are of the earth, earthy; are mechanical, and are unintellectual, and that even the mere bookworm, who, content with storing his own mind, neither distributes those stores to others, nor himself originates, is more worthily occupied than is the civil engineer.

I deny this altogether, and while acknowledging with gratitude that in literature the masterpieces of master minds have afforded, and will afford, instruction, delight, and solace for all generations so long as civilisation endures, I say that the pursuits of civil engineering are worthy of occupying the highest intelligence, and that they are elevating and ennobling in their character.

Remember the kindly words of Sir Thomas Browne, who said, when condemning the uncharitable conduct of the mere bookworm, "I make not, therefore, my head a grave, but a treasure of knowledge, and study not for mine own sake only, but for those who study not for themselves." The engineer of the present day finds that he must not make his "head a grave," but that, if he wishes to succeed, he must have, and must exercise, scientific knowledge; and he realises daily the truth that those who are to come after him must be trained in science, so that they may readily appreciate the full value of each scientific discovery as it is made. Thus the application of science by the engineer not only stimulates those who pursue science, but adds him to their number.

Holding, as I have said I do, the view that he who displaces unintelligent labour is doing good to mankind, I claim for the unknown engineer who, in Pontus, established the first water-wheel of which we have a record, and for the equally unknown engineer who first made use of wind for a motor, the title of pioneers in the raising of the dignity of labour, by compelling the change from the non-intelligent to the intelligent.

With respect to these motors—wind and water—we have two proverbs which discredit them: "Fickle as the wind," "Unstable as water."

Something more trustworthy was needed—something that we were sure of having under our hands at all times. As a result, science was applied, and the "fire" engine, as it was first called, the "steam" engine, as it was re-named, "a form of "heat" engine, as we now know it to be, was invented.

Think of the early days of the steam-engine—the pre-Watt days. The days of Papin, Savory, Newcomen, Smeaton! Great effects were produced, no doubt, as compared with no fire-engine at all; effects so very marked as to extort from the French writer, Belidor, the tribute of admiration he paid to the "fire" engine erected at the Fresnes Colliery by English engineers. A similar engine worked the pumps in York-place (now the Adelphi) for the supply of water to portions of London. We have in his work one of the very clearest accounts, illustrated by the best engravings (absolute working drawings) of the engine which had excited his admiration. These drawings show the open-topped cylinder, with condensation taking place below the piston, but with the valves worked automatically.

It need hardly be said that, noteworthy as such a machine was, as compared with animal power, or with wind or water motors, it was of necessity a most wasteful instrument as regards fuel. It is difficult to conceive in these days how, for years, it could have been endured that at each stroke of the engine the chamber that was to receive the steam at the next stroke was carefully cooled down beforehand by a water injection.

Watt, as we know, was the first to perceive, or, at all events, to cure, this fundamental error which existed prior to his time in the "fire" engine. To him we owe condensation in a separate vessel, the doing away with the open-topped cylinder, and the making the engine double-acting; the parallel motion; the governor; and the engine indicator, by which we have depicted for us the way in which the work is being performed within the cylinder. To Watt, also, we owe that great source of economic working—the knowledge of the expansive force of steam; and to his prescience we owe the steam jacket, without which expansion, beyond certain limits, is practically worthless. I have said "prescience"—fore-knowledge—but I feel inclined to say that, in this case, prescience may be rendered "pre-science," for I think that Watt *felt* the utility of the steam jacket, without being able to say on what ground that utility was based.

I have already spoken in laudatory terms of Tredgold, as being one of the earliest of our scientific engineering writers; but, as regards the question of steam jacketing, Watt's pre-science was better than Tredgold's science, for the latter condemns the steam jacket as being a means whereby the cooling surfaces are enlarged, and whereby, therefore, the condensation is increased.

I think it is not too much to say that engineers who, since Watt's days, have produced machines of such marvellous power—and, compared with the engines of Watt's days, of so great economy—have, so far as principles are concerned, gone upon those laid down by Watt. Details of the most necessary character—necessary to enable those principles to be carried out—have, indeed, been devised since the days of Watt. Although it is still a sad confession to have to make, that the very best of our steam-engines only utilises about one-sixth of the work which resides (if the term may be used) in the fuel that is consumed, it is, nevertheless, a satisfaction to know that great economical progress has been made, and that the 6lb. or 7lb. of fuel per h.p. per hour consumed by the very best engines of Watt's days, when working with the aid of condensation, is now brought down to about one-fourth of this consumption; and this in portable engines, for agricultural purposes, working without condensation—engines of small size, developing only 20 h.p.; in such engines the consumption has been reduced to as little as 1·85lb. per brake h.p. per hour, equal to 1·65lb. per

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i.h.p. per hour, as was shown by the trials at the Royal Agricultural Society's meeting at Newcastle last year—trials in which I had the pleasure of participating.

In these trials, Mr. William Anderson, one of the vice-presidents of Section G, and I were associated; and, in making our report of the results, we adopted the balance-sheet system, which I suggested and used so long ago as 1873 (see vol. lii., pages 154 and 155 of the minutes of *Proceedings* of the Institution of Civil Engineers), and to which I alluded in my address as president of G, at Montreal.

I have told you that the engineer of the present day appreciates the value of the "next-to-nothings." There is an old housekeeping proverb that, if you take care of the farthings and the pence, the shillings and the pounds will take care of themselves. Without the balance-sheet, one knows that for the combustion of 1lb. of coal, the turning into steam of a given quantity of water at a given pressure is obtained. It is seen at once that the result is much below that which should be had, but to account for the deficiency is the difficulty. The balance-sheet, dealing with the most minute sources of loss—the farthings and the pence of economic working—brings you face to face with these, and you find that improvement must be sought in paying attention to the "next-to-nothings."

Just one illustration. The balance-sheet will enable you at a glance to answer this among many important questions. Has the fuel been properly burnt?—with neither too much air nor too little.

At the Newcastle trials our knowledge as to whether we had the right amount of air for perfect combustion was got by an analysis of the waste gases, taken continuously throughout the whole number of hours' run of each engine, affording, therefore, a fair average. The analysis of any required portion of gases thus obtained was made in a quarter of an hour's time by the aid of the admirable apparatus invented by Mr. Stead, and on the occasion to which I refer manipulated by him. In one instance an excess of air had been supplied, causing a percentage of loss of 6·34. In the instance of another engine there was a deficiency of air, resulting in the production of carbonic oxide, involving a loss of 4 per cent. The various percentages of loss, of which each one seems somewhat unimportant, in the aggregate amounted to 28 per cent., and this with one of the best boilers. This is an admirable instance of need of attention to apparently small things.

I have already said that we now know the steam-engine is really a heat-engine. At the York meeting of our Association I ventured to predict that, unless some substantive improvement were made in the steam-engine (of which improvement, as yet, we have no notion), I believed its days, for small powers, were numbered, and that those who attended the centenary of the British Association in 1931 would see the present steam-engines in museums, treated as things to be respected, and of antiquarian interest to the engineers of those days, such as are the open-topped steam-cylinders of Newcomen and of Smeaton to ourselves. I must say I see no reason, after the seven years which have elapsed since the York meeting, to regret having made that prophecy, or to desire to withdraw it.

The working of heat-engines, without the intervention of the vapour of water, by the combustion of the gases arising from coal, or from coal and from water, is now not merely an established fact, but a recognised and undoubted commercially economical means of obtaining motive power. Such engines, developing from 1 to 40 h.p., and worked by the ordinary gas supplied by the gas mains, are in most extensive use in printing works, hotels, clubs, theatres, and even in large private houses, for the working of dynamos to supply electric light. Such engines are also in use in factories, being sometimes driven by the gas obtained from "culm" and steam, and are giving forth a h.p. for, it is stated, as small a consumption as one pound of fuel per hour.

It is hardly necessary to remind you—but let me do it—that, although the saving of half a pound of fuel per h.p. appears to be insignificant when stated in that bald way, one realises that it is of the highest importance when that half-pound turns out to be 33 per cent. of the whole previous consumption of one of those economical engines to which I have referred.

The gas-engine is no new thing. As long ago as 1807, a M. de Rivaz proposed its use for driving a carriage on ordinary roads. For anything I know, he may not have been the first proposer. It need hardly be said that in those days he had not illuminating gas to resort to, and he proposed to employ hydrogen. A few years later, a writer in *Nicholson's Journal*, in an article on "flying machines," having given the correct statement that all that is needed to make a successful machine of this description is to find a sufficiently light motor, suggests that the direction in which this may be sought is the employment of illuminating gas, to operate by its explosion on the piston of an engine. The idea of the gas-engine was revived, and formed the subject of a patent by Barnett in the year 1838. It is true this gentleman did not know very much about the subject, and that he suggested many things which, if carried out, would have resulted in the production of an engine which could not have worked; but he had an alternative proposition which would have worked.

Again, in the year 1861 the matter was revived by Lenoir, and in the year 1865 by Hugon, both French inventors. Their engines obtained some considerable amount of success and notoriety, and many of them were made and used; but in the majority of cases they were discarded as wasteful and uncertain. The Institution of Civil Engineers, for example, erected a Lenoir in the year 1868 to work the ventilating fan, but after a short time they were compelled to abandon it, and to substitute an hydraulic engine.

At the present time, as I have said, gas-engines are a great commercial success, and they have become so by the attention given to small things, in popular estimation—to important things, in fact, with which, however, I must not trouble you. Messrs. Crossley Brothers, who have done so much to make the gas-engine the commercial success that it is, inform me that they are prosecuting improvements in the direction of attention to detail, from which they are obtaining greatly improved results.

But, looking at the wonderful petroleum industry, and at the multifarious products which are obtained from the crude material, is it too much to say that there is a future for motor-engines worked by the vapour of some of the more highly volatile of these products—true vapour—not a gas, but a condensable body, capable of being worked over and over again? Numbers of such engines, some of as much as 4 h.p., made by Mr. Yarrow, are now running, and are apparently giving good results—certainly excellent results as regards the compactness and lightness of the machinery. For boat purposes, they possess the great advantage of being rapidly under way. I have seen one go to work within two minutes of the striking of the match to light the burner.

Again, as we know, the vapour of this material has been used as a gas in gas-engines, the motive power having been obtained by direct combustion.

Having regard to these considerations, was I wrong in predicting that the heat-engine of the future will probably be one independent of the vapour of water? And, further, in these days of electrical advancement it is too much to hope for the direct production of electricity from the combustion of fuel?

As the world has become familiar with prime movers, the desire for their employment has increased. Many a householder could find useful occupation for a prime mover of ¼ or ½ h.p., working one or two hours a day; but the economical establishment of a steam-engine is not possible until houses of very large dimensions are reached, where space exists for the engine, and where, having regard to the amount of work to be done, the incidental expenses can be borne. Where this cannot be, either the prime mover, with the advantages of its use, must be given up as a thing to be wished for, but not to be procured, or recourse must be had to some other contrivance—say to the laying on of power in some form or another, from a central source.

I have already incidentally touched upon one mode of doing this—namely, the employment of illuminating gas, as the working agent in the gas-engine; but there are various other modes, possessing their respective merits and demerits—all ingenious, all involving science in their application, and all more or less in practical use—such as the laying-on of special high-pressure water, as is now being extensively practised in London, in Hull, and elsewhere. Water at 700lb. pressure per inch is a most convenient mode of laying on a large amount of power through comparatively small pipes. Like electricity, where, when a high E.M.F. is used, a large amount of energy may be sent through a small conductor, so with water, under high pressure, the mains may be kept of reasonable diameters without rendering them too small to transmit the power required through them

Power is also transmitted by means of compressed air, an agent which, on the score of its ability to ventilate, and of its cleanliness, has much to recommend it. On the other hand, it is an agent which, having regard to the probability of the deposition of moisture in the form of "snow," requires to be worked with judgment.

Again, there is an alternative mode for the conveyance of power by the exhaustion of air—a mode which has been in practical use for over sixty years.

We have also the curious system pursued at Schaffhausen, where quick-running ropes are driven by turbines, these being worked by the current of the river Rhine; and at New York, and in other cities of the United States, steam is laid on under the streets, so as to enable domestic steam-engines to be worked without the necessity of a boiler, a stoker, or a chimney, the steam affording also means of heating the house when needed.

Lastly, there is the system of transmitting power by electricity, to which I have already adverted. I was glad to learn, only the other day, that there was every hope of this power being applied to the working of an important subterranean tramway.

These distributions from central sources need, as a rule, statutory powers to enable the pipes or wires to be placed under the roads; and, following the deplorable example of the Electrical Facilities Act, it is now the habit of the enlightened corporation and the enterprising town clerk of most boroughs

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to say to capitalists who are willing to embark their capital in the plant for the distribution of power from a central source—for their own profit, no doubt, but also, no doubt, for the good of the community—"We will oppose you in Parliament, unless you will consent that, at the end of twenty-one years, we may acquire compulsorily your property, and may do so, if it turns out to be remunerative, without other payment than that for the mere buildings and plant at that time existing." This is the way English enterprise is met, and then English engineers are taunted by Englishmen—often by the very men who have had a share in making this "boa-constrictor" of a "Facilities Act"—that their energy is not to be compared with that which is to be found in the United States and other countries. Again, however, I must remember that I am not addressing Section F.

There is one application of science, by engineers, which is of extreme beauty and interest, and that cannot be regarded with indifference by the agriculturists of this country. I allude to the heat-withdrawing engines (I should like to say, "cold-producers," but I presume, if I did, I should be criticised), which are now so very extensively used for the importation of fresh meat, and for its storage when received here. It need hardly be said, that that which will keep cool and sweet the carcases of sheep will equally well preserve milk and many other perishable articles of food. We have in these machines daily instances that, if you wish to make a ship's hold cold, you can do it by burning a certain quantity of coals—a paradox if ever there was one.

In this climate of ours, where the summer has been said to consist of "three hot days and a thunderstorm," there is hardly need to make a provision for cooling our houses, although there is an undoubted need for making a provision to heat them. Nevertheless, those of us who have hot-water heating arrangements for use in the winter would be very glad indeed if, without much trouble or expense, they could turn these about so as to utilise them for cooling their houses in summer. Mr. Loftus Perkins, so well known for his labours in the use of very high-pressure steam (600 to 1,000lb. on the inch), and also so well known for those most useful high-pressure warming arrangements which, without disfiguring our houses by the passage of large pipes, keep in a state of warmth and comfort throughout the winter, has lately taken up the mode of, I will say it, producing "cold" by the evaporation of ammonia, and, by improvements in detail, has succeeded in making an apparatus which, without engine or pumps, produces "cold" for some hours in succession, and requires, to put it in action, the preliminary combustion of only a few pounds of coke or a few feet of gas.

As I have said, our climate gives us but little need to provide or employ apparatus to cool our houses, but no one can well imagine that the Anglo-Indian will be glad to give up his punkah for some more certain, and less draughty, mode of cooling.

I now desire to point out how, as the work of the engineer grows, his needs increase. New material, or better material of the old kind, has to be found to enable him to carry out these works of greater magnitude. At the beginning of this century, stone, brick, and timber were practically the only materials employed for that which I may call standing engineering work—*i.e.*, buildings, bridges, aqueducts, and so on—while timber, cast iron, and wrought iron were for many years the only available materials for the framing and principal parts of moving machines and engines, with the occasional use of lead for the pipes and of copper for pipes and for boilers.

As regards the cast iron, little was known of the science involved (or that ought to be involved) in its manufacture. It was judged of by results. It was judged of largely by the eye. It was "white," it was "mottled," it was "grey." It was known to be "fit for refining," fit for "strong castings," or fit for castings in which great fluidity in the molten metal was judged to be of more importance than strength in the finished casting. With respect to wrought iron, it was judged of by its results also. It was judged of by the place of its manufacture; but when the works of the district were unknown, the iron, on being tested, was classed as "good fibrous," although some of the very best was "steel-like," or "bad," "hot-short," or "cold-short." A particular district would produce one kind of iron, another district another kind of iron. The ore, the flux, and the fuel were all known to have influence, but to what extent was but little realised; and if there came in a new ore, or a new flux, it might well be that for months the turn-out of the works into which these novelties had been introduced would be prejudiced. Steel again—that luxury of the days of my youth—was judged by the eye. The wrought bars, made into "blister" steel by "cementation," were broken, examined, and grouped accordingly. Steel was known, no doubt, to be a compound of iron and carbon, but the importance of exactness in the percentage was but little understood, nor was it at all understood how the presence of comparatively small quantities of foreign matter might necessitate the variation of the proportions of carbon. The consequence was that anomalous results every now and then arose to confound the person who had used the steel, and, falsifying the proverb "true as steel," steel became an object of distrust. Is it too much to say that Bessemer's great invention of steel made by the "converter" and that Siemens' invention of the open-hearth process reacted on pure science, and set scientific men to investigate the laws which regulate the union of metals and of metalloids? and that the labours of these scientific men have improved the manufacture, so that steel is now thoroughly and entirely trusted? By its aid engineering works are accomplished which without that aid would have been simply impossible. The Forth Bridge, the big gun, the compound armour of the ironclad, with its steel face, the projectile to pierce that steel face—all equally depend upon the "truth" of steel as much as does the barely visible hair-spring of the chronometer, which enables the longitude of the ship in which it is carried to be ascertained. Now what makes the difference between trustworthy and untrustworthy steel for each particular purpose? Something which, until our better sense comes to our aid, we are inclined to look upon as ridiculously insignificant—a "next-to-nothing." Setting extraneous ingredients aside, and considering only the union of iron and carbon, the question whether there shall be added or deducted one-tenth of one per cent. (pardon my clumsy way of using the decimal system) of carbon is a matter of great importance in the resulting quality of the steel. This is a striking practical instance of how apparently insignificant things may be of the highest importance. The variation of this fraction of a percentage may render your boiler steel untrustworthy, may make the difference between safety in a gun and danger in a gun, and may render your armour-piercing projectile unable to pierce even the thinnest wrought-iron armour.

While thus brought incidentally to the subject of guns, let me derive from it another instance of the value of small things. I have in my hand a piece of steel ribbon. It is probable that only those who are near to me can see it. Its dimensions are one-fourth by one-sixteenth of an English inch, equal to an area of one sixty-fourth of a square inch. This mode of stating the dimensions I use for the information of the ladies. To make it intelligible to my scientific friends, I must tell them that it is approximately ·00637 of a metre, by approximately ·00159 of a metre, and that its sectional area is ·0000101283 (also approximately) of a square metre. This insignificant and (speaking in reference to the greater number of my audience) practically invisible piece of material—that I can bend with my hand, and even tie into knots—is, nevertheless, not to be despised. By it one reinforces the massive and important-looking A-tube of a 9·2-in. gun, so that from that tube can be projected with safety a projectile weighing 380lb. at a velocity, when leaving the muzzle, of between one-third and one-half of a mile in a second, and competent to traverse nearly 12½ miles before it touches the ground. It may be said, "What is the use of being able to fire a projectile to a distance which, commonly, is invisible—from some obstacle or another—to the person directing the gun?" I will suggest to you a use. Imagine a gun of this kind placed by some enemy who unfortunately had invaded us, and had reached Richmond. He has the range table for his gun; he, of course, is provided with our ordnance maps, and he lays and elevates the gun at Richmond with the object of striking, say, the Royal Exchange. Suppose he does not succeed in his exact aim. The projectile goes 100 yards to one side or to the other, or it falls 250 yards short or passes 250 yards over; and it would be "bad shooting" indeed, in these days, if nearly every projectile which was fired did not fall somewhere within an area such as this. In this suggested parallelogram of 100,000 square yards, or some 20 acres, there is some rather valuable property; and the transactions which are carried on are not unimportant. It seems to me that business would not be conducted with that calmness and coolness which are necessary for success, if, say every five minutes, a 380-pound shell fell within this area, vomiting fire, and scattering its walls in hundreds of pieces, with terrific violence, in all directions. Do not suppose I am saying that similar effects cannot be obtained from a gun where wire is not employed. They can be. But my point is, that they can also be obtained by the aid of the insignificant thing which I am holding up at this moment—this piece of steel ribbon, which looks more suitable for the framework of an umbrella.

I have already spoken to you, when considering steel as a mere alloy of iron, as to the value of even a fraction of 1 per cent. of the carbon; but we know that in actual practice steel almost always contains other ingredients. One of the most prominent of these is manganese. It had for years been used, in quantities varying from a fraction of 1 per cent. up to 2·5 per cent., with advantage as regards ductility, and as regards its ability to withstand forging. A further increase was found not to augment the advantage; a still further increase was found to diminish it, and here the manufacturer stopped; and, so far as I know, the pure scientist stopped, on the very reasonable ground that the point of increased benefit appeared to have been well ascertained, and there could be no advantage in pursuing an investigation which appeared only to result in decadence. But this is another instance of how the application

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of science reacts in the interests of pure science itself. One of our steel manufacturers, Mr. Hadfield, determined to pursue this apparently barren subject, and in doing so discovered this fact—that, while with the addition of manganese in excess of the limit before stated, and up to as much as 7 per cent. deterioration continued, after this latter percentage was passed improvement again set in.

Again, the effects of the addition of even the very smallest percentages of aluminium upon the steel with which it may be alloyed are very striking and very peculiar, giving to the steel alloy thus produced a very much greater hardness, and enabling it to take a much brighter and more silver-like polish. Further, the one-twentieth part of 1 per cent. of aluminium, when added to molten wrought iron, will reduce the fusing-point of the whole mass some 500 degrees, and will render it extremely fluid, and thus enable wrought iron (or what are commercially known as "Mitis"—castings of the most intricate character) to be produced.

No one has worked more assiduously at the question of the effect of the presence of minute quantities, even traces of alloys with metals, than Prof. Roberts-Austen, and he appears, by his experiments, to be discovering a general law governing the effect produced by the mixture of particular metals, so that, in future, it is to be hoped, when an alloy is for the first time to be attempted, it will be possible to predict with reasonable certainty what the result will be, instead of that result remaining to be discovered by experiment.

I have just, incidentally, mentioned aluminium. May I say that we engineers look forward with much interest to all processes tending to bring this metal, or its alloys, within possible commercial use?

One more instance of the effect of impurities in metals. The engineer engaged in electrical matters is compelled, in the course of his daily work, frequently to realise the importance of the "next-to-nothing." One striking instance of this is afforded by the influence which an extremely minute percentage of impurity has on the electrical conductivity of copper wire; this conductivity being in some cases reduced by as much as 50 per cent., in consequence of the admixture of that which, under other circumstances, would be looked upon as insignificant.

Reverting to the question of big guns. According to the present mode of manufacture, after we have rough-bored and turned the "A" tube (and perhaps I ought to have mentioned that by the "A" tube is meant the main piece of the gun, the innermost layer, if I may so call it, that portion which is the full length of the gun, and upon which the remainder of the gun is built up)—after, as I have said, we have rough-bored and turned this "A" tube, we heat it to a temperature lying between certain specified limits, but actually determined by the behaviour of samples previously taken, and then suddenly immerse it perpendicularly into a well some 60ft. deep, full of oil, the oil in this well being kept in a state of change by the running into it, at the bottom, of cold oil, conveyed by a pipe proceeding from an elevated oil tank. In this way the steel is oil-hardened, with the result of increasing its ultimate tensile strength, and also with the result of raising its so-called elastic limit. In performing this operation it is almost certain that injurious internal strains will be set up: strains tending to produce self-rupture of the material. Experiments have been carried out in England, by Captain Andrew Noble, and by General Maitland of the Royal Gun Factory, by General Kalakoutsky, in Russia, and also in the United States, to gauge what is the value, as represented by dimensions, of these strains, and we find that they have to be recorded in the most minute fractions of an inch, and yet, if the steel be of too "high" a quality (as it is technically called), or if there has been any want of uniformity in the oil-hardening process, these strains, unless got rid of or ameliorated by annealing, may, as I have said, result in the self-rupture of the steel.

I have spoken of the getting rid of these strains by annealing, a process requiring to be conducted with great care, so as not to prejudice the effects of the oil-hardening. But take the case of a hardened steel projectile, hardened so that it will penetrate the steel face of compound armour. In that case annealing cannot be resorted to, for the extreme hardness of the projectile must not be in the least impaired. The internal strains in these projectiles are so very grave, that for months after they are made there is no security that they will not spontaneously fracture. I have here the point of an 8in. projectile, which projectile weighs 210lb. This, with others, was received from the makers as long ago as March of this year, and remained an apparently perfect and sound projectile until about the middle of August—some five months after delivery—and, of course, a somewhat longer time since manufacture; and between August 6th and 8th this piece which I hold in my hand, measuring 3¾in. by 3½in., spontaneously flew off from the rest of the projectile, and has done so upon a surface of separation which, whether having regard to its beautiful regularity, or to the conclusions to be drawn from it as to the nature of the strains existing, is of the very highest scientific interest. Many other cases of self-rupture of similar projectiles have been recorded.

Another instance of the effect of the "next-to-nothing" in the hardening and tempering or annealing of steel. As we know, the iron and the carbon (leaving other matters out of consideration) are there. The carbon is (even in tool steel) a very small proportion of the whole. The steel may be bent, and will retain the form given to it. You heat it, and plunge it in cold water; you attempt to bend it, and it breaks; but if, after the plunging in cold water, you temper it by carefully reheating it, you may bring it to the condition fit either for the cutting-tool for metal or for the cutting-tool for wood, or for the watch-spring; and these important variations of condition which are thus obtained depend upon the "next-to-nothing" in the temperature to which it is reheated, and, therefore, in the nature of the resulting combination of the ingredients of which the steel is composed.

Some admirable experiments were carried out on this subject by the Institution of Mechanical Engineers, with the assistance of one of our vice-presidents, Sir Frederick Abel, and the subject has also been dealt with by an eminent Russian writer.

There is, to my mind, another and very striking popular instance (if I may use the phrase) of the importance of attention to detail—that is, to the "next-to-nothing." Consider the bicycles and tricycles of the present day—machines which afford the means of healthful exercise to thousands, and which will probably within a very short time prove of the very greatest possible use for military purposes. The perfection to which these machines have been brought is almost entirely due to strict attention to detail; in the selection of the material of which the machines are made; in the application of pure science (in its strictest sense) to the form and to the proportioning of the parts, and also in the arrangement of these various parts in relation the one to the other. The result is that the greatest possible strength is afforded with only the least possible weight, and that friction in working has been reduced to a minimum. All of us who remember the hobby-horse of former years, and who contrast that machine with the bicycle or tricycle of the present day, realise how thoroughly satisfactory is the result of this attention to detail—this appreciation of the "next-to-nothing."

Let me give you another illustration of the importance of small things, drawn from gunnery practice.

At first sight one would be tempted to say that the density of the air on the underside of a shot must, notwithstanding its motion of descent, be so nearly the same as that of the air upon the upper side as to cause the difference to be unworthy of consideration, but we know that the projectiles from rifled guns tend to travel sideways as they pass through the air, and that the direction of their motion, whether to the right or to the left, depends on the "hand" of the rifling. We know also that the friction against liquid or against gaseous bodies varies with the densities of these bodies, and it is believed that, minute as is the difference in density to which I have referred, it is sufficient to determine the lateral movement of the projectile. This lateral tendency must be allowed for, in these days of long ranges, in the sighting and laying of guns, if we desire accuracy of aim, at those distances at which it is to be expected our naval engagements will have to be commenced, and perhaps concluded. We can no longer afford to treat the subject as Nelson is said to have treated it in one of his letters to the Secretary of the Admiralty, who had requested that an invention for laying guns more accurately should be tried. Nelson said he would be glad to try the invention, but that as his mode of fighting consisted in placing his ship close alongside that of the enemy, he did not think the invention, even if it were successful, would be of much use to him.

While upon the question of guns, I am tempted to remark upon that which is by no means a small thing (for it is no less than the rotation of the earth), which in long-distance firing may demand attention, and that to an extent little suspected by the civilian.

Place the gun north and south, say in the latitude of London, and fire a twelve-mile round such as I have mentioned, and it will be found that, assuming the shot were passing through a vacuum, a lateral allowance of more than 200ft. must be made to compensate for the different velocity of the circumference of the earth at twelve miles north or south of the place where the gun was fired, as compared with the velocity of the circumference of the earth at that place itself—the time of flight being in round numbers one minute.

At the risk of exciting a smile, I am about to assert that engineering has even its poetical side. I will ask you to consider with me whether there may not be true poetry in the feelings of the engineer who solves a problem such as this: Consider this rock, never visible above the surface of the tide, but making its presence known by the waves which rise around it: it has been the cause of destruction to many a noble vessel which had completed, in safety, its thousands of leagues of journey, and was within a few score miles of port; then dashed to pieces upon it? Here is this rock. On it build a lighthouse. Lay your foundations through the water, in the midst of the turmoil of the sea; make your preparations; appear to be attaining success, and find the elements are against you, and that the

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whole of your preliminary works are ruined or destroyed in one night; but again commence, and then go on and go on until at last you conquer; your works rise above ordinary tide-level; then upon these sure foundations, obtained it may be after years of toil amid the poetical surroundings I have indicated, erect a fair shaft, graceful as a palm and sturdy as an oak; surmount it with a light, itself the produce of the highest application of science; direct that light by the built-up lens, again involving the highest application of science; apply mechanism, so arranged that the lighthouse shall from minute to minute reveal to the anxious mariner its exact name and its position on the coast. When you have done all this, will you not be entitled to say to yourself, "It is I who have for ever rendered innocuous this rock which has been hitherto a dread source of peril?" Is there no feeling, do you think, of a poetical nature excited in the breast of the engineer who has successfully grappled with a problem such as this?

Another instance; the mouth of a broad river, or, more properly speaking, the inlet of the sea, has to be crossed at such a level as not to impede the passage of the largest ships. Except in one or two places the depth is profound, so that multiple foundations for supporting a bridge become commercially impossible, and the solution of the problem must be found by making, high in the air, a flight of span previously deemed unattainable. Is there no poetry here? Again, although the results do not strike the eye in the same manner, is there nothing of poetry in the work, that has to be thought out and achieved, when a wide river or an ocean channel has to be crossed by a subterranean passage. Works of great magnitude of this character have been performed with success, and to the benefit of those for whose use they were intended. One of the greatest and most noble of such works, encouraged, in years gone by, by the Governments of our own country and of France, has lately fallen into disfavour with an unreasoning public, who have not taken the pains to ascertain the true state of the case.

Surely it will be agreed that the promotion of ready intercourse and communication between nations constitute the very best and most satisfactory guarantees for the preservation of peace; when the peoples of two countries come to know each other intimately, and when they, therefore, enter into closer business relations, they are less liable to be led away by panic or by anger, and they hesitate to go to war the one with the other. It is in the interests of both that questions of difference which may arise between them should be amicably settled, and having an intimate knowledge of each other, they are less liable to misunderstand, and the mode of determination of their differences is more readily arranged. Remember, the means of ready intercourse and of communication, and the means of easy travel, are all due to the application of science by the engineer. Is not, therefore, his profession a beneficent one?

Further, do you not think poetical feeling will be excited in the breast of that engineer, who will in the near future solve the problem (and it certainly will be solved when a sufficiently light motor is obtained) of travelling in the air—whether this solution be effected by enabling the self-suspended balloon to be propelled and directed—or, perhaps, better still, by enabling not only the propulsion to be effected and the direction to be controlled, but by enabling the suspension in the air itself to be attained by mechanical means?

Take other functions of the civil engineer—functions which, after all, are of the most important character, for they contribute directly to the prevention of disease, and thereby not only prolong life, but do that which is probably more important—afford to the population a healthier life while lived.

In one town, about which I have full means of knowing, the report has just been made that in the year following the completion of a comprehensive system of sewerage, the deaths from zymotic diseases had fallen from a total of 740 per annum to a total of 372—practically one half. Has the engineer no inward satisfaction who knows such results as these have accrued from his work?

Again, consider the magnitude and completeness of the water supply of a large town, especially a town that has to depend upon the storing-up of rain water; the provision which takes into account, not merely the variation of the different seasons of the year, but the variation of one year from another; that, having collated all the stored-up information, determines what must be the magnitude of the reservoirs to allow for at least three consecutive dry years, such as may happen; and that finds the sites where these huge reservoirs may be safely built.

All these—and many other illustrations which I could put before you if time allowed—appear to me to afford conclusive evidence that, whether it be in the erection of the lighthouse on the lonely rock at sea; whether it be in the crossing of rivers or seas, or arms of seas, by bridges or by tunnels; whether it be the cleansing of our towns from that which is foul; whether it be the supply of pure water to every dwelling, or the distribution of light or motive power; or whether it be in the production of the mighty ocean steamer, or in the spanning of valleys, the piercing of mountains, and affording the firm, secure road for the express train; or whether it be the encircling of the world with telegraphs—the work of the civil engineer is not of the earth earthy, is not mechanical to the exclusion of science, is not unintellectual; but is of a most beneficent nature, is consistent with true poetical feeling, and is worthy of the highest order of intellect.

THE PROTECTION OF ELECTRIC LIGHT STATIONS FROM LIGHTNING.

BY W. J. JENKS.

(*Continued from page 188.*)

Perhaps the most vital portion of any street system of lightning protection is the connection established beneath the surface of the earth. If we proceed upon the basis of the theory of powerful attraction to localities or lines of electric tension, it is essential that we either connect directly with these channels or terminate our conductors so that the descending charge shall reach them by the most direct way possible.

Imperfect Ground Connections.—In 1878, before the days of cheap magneto call-bells, I had occasion to connect the shooting station of a 1,000-yard rifle range with the markers' pit at the targets by a telephone line. The wire was No. 12 iron, substantially erected on poles. The ground at the shooting shed, a plate 1ft. or 2ft. square, in a small stream, was undoubtedly good. After passing over the 3,000ft. interval and through the target instruments, the line was carefully connected with an inch iron bar driven from 3ft. to 4ft. into the ground at the bottom of the pits. To my amazement, four freshly-made Daniell cells failed to operate a single 25-ohm tap bell over this line. Four more showed no better result. A third instalment, making twelve in all, wouldn't make the bell wink. A second iron rod was added, and both together driven into the clayey soil failed to operate. Another branch to a third rod a hundred feet down the side hill was likewise ineffectual. Any one of them would work the telephone, but we had to run a return wire back to the station to make a reliable circuit, and then the two bells were easily operated over the 6,000ft. of wire with two cells of battery. The entire slope, perhaps the tree-crowned hill behind it, was highly insulated from the arteries leading to the electrical reservoir below.

There are whole valleys in the Lake Superior copper region thus electrically isolated from the earth's channels, and it is said that lightning has never been known to strike them.

A noted European electrician who spent years in cable work once told me a story almost incredible as to this peculiar condition of localities on the earth surface. A trans-Atlantic cable has been laid on an island off the Irish coast, and here the repeating station was to be placed—the point where the language of the shadow signs, or the syphon recorder is translated into Morse dots and dashes. The usual ground-plate of copper, about 5 or 6 square feet, had been buried in the scanty soil which bounded the rocky coast. The battery was applied, but no signal went out. Beyond question, the cable itself was perfect. Another plate of 10 square feet was buried, just above low-water mark, in the sand. This gave a current so faint that it could barely be perceived. Still another plate 6ft. square (36 square feet in area—or, on both sides, 72 square feet of exposed surface) was covered 3ft. deep in sand and mud. Still no practical result. The expert was staggered. Delicate Thomson galvanometers were barely deflected by a hair's breadth. In disgust he tried once more, this time taking several pounds of shingle nails, and, uncovering the broad face of the copper sheet, drove the nails through, about half an inch apart, over its entire surface. Then, the hundreds of nail points and thousands of minute slivers and crystalline faces of copper exposed to contact with the earth and water made a connection of so low resistance that the current flowed freely through with perfect results.

One more illustration from telephone experience. In 1880 the American Bell Telephone Company began to license the construction of "extra-territorial" lines, connecting widely separated exchanges. One of the first was built for the Inter-State Telephone Company from Boston, the cradle of the telephone industry, to Providence, by

*Abstract of paper read before the Association of Edison Companies.

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wire 50 miles. The construction was most substantial, and it was expected that in a short time the magnificent line of 40ft., 50ft., and 60ft. poles would carry the 50 wires which were provided for. It was at that time a theory with the "experts" that interference or cross-talk was merely leakage, and so to carry away the currents which by any means might creep over the glass and its support, a sheet-iron collar was arranged to surround the base of each pin and connect with a wire under the cross arm, joining another leading down from the point of the pole and winding several times around its base. Here it was supposed to make a perfect earth connection. Measurements showed the resistance of these grounds to be all the way from 100 to 3,000 ohms each. Occasionally, where the soil was very wet, the results would be better, and of course even the worst of such grounds will avoid the destruction of the pole by the splintering from top to bottom which often occurs where the current can find no better conductor than the moisture in the pores of the wood.

Whatever may be the retarding influence of poor conductors upon the intensity or explosive action of a discharge, it is certain that at all times the duration of the lightning flash is inconceivably short. This is illustrated by the fact that the rapidly revolving spinning-wheel is seen by the lightning flash as if perfectly stationary. Wheatstone estimated that the lightning flash occupied less than one-millionth part of a second. As the full effect of any sudden light upon the eye requires one-tenth of a second, it is plain that we can neither appreciate the almost infinite velocity of the current nor the brilliancy of the illumination. Were the lightning permanent, the apparent brightness would probably be one hundred thousand times greater than we now experience.

Hence, the common statement that the direction of the spark can be seen is plainly incorrect, and must arise from the optical illusion excited by the greater sensitiveness of the central parts of the eye. Hence, the point seen directly in front of the eye affects the brain sooner than the rest.

Everthing points to the reasonableness of the idea that, other things being equal, certain lines or points beneath the surface strive to interchange their energy with the points of the clouds most densely charged, and will do it in straight lines unless some tremendous resistance is set up by an insulating material, or by the action of the rush of current upon the conductors in its way. A vast system of water pipes, which affords the best possible ground connection for all circuits of low pressure, sometimes proves entirely inadequate to discharge the tremendous energy of the thunder cloud without a rupture of the iron mains.

A flash that finds its way from a small wire into a network of iron pipes may, in leaving that network at a certain point of maximum attraction, rend the metal asunder with an explosive force which we can only estimate, and cause disastrous effects in the system. These, of course, are the exceptions.

Gas-pipes should not, under any circumstances, be used as grounds, except as connection may be made outside the meter; in fact, outside of all joints within buildings, because the leaded joints themselves are likely to offer resistance, and induce a spark which may fire the gas, or a melting action which may entirely open the pipe, and cause the firing of combustible material. A melting out of the meters is often traceable to this cause.

One of the best earth connections may generally be made by a copper plate from 3 to 6 square feet in area, so placed at the bottom of a well that it will come into intimate contact with the soil itself. Another very desirable form may be arranged by burying a large quantity of grey retort carbon or charcoal in damp soil, and this again may be still further improved by leading to this bed of carbon a water spout from the roof. In many cases it is possible to get a most desirable form of ground connection by burying a large plate at the terminus of a drain or in the bed of a stream. That the stream, alone, however, cannot be relied upon as affording a distributing channel has been more than once demonstrated. Here is an illustration of an instance which came under my own observation. A forest tree was struck and partially shattered, the charge leaving its trunk some six feet from the earth, running along the surface, deliberately jumping a stream at least six feet in width and ploughing up the earth beyond for some distance, finally boring a hole vertically over what was presumably a subterranean water course, or similar line of attraction.

(To be concluded.)

THE AUSTRALIAN CABLES.

BY W. J. HANCOCK, M.S.T.E.

The Australian Duplicate Cable line branches off from the Eastern Extension Telegraph Company's extensive system at Singapore. Messages by the old cable go from Singapore to Batavia; and from Batavia across Java to Barjoewangie, thence by a cable which skirts the islands of Sumbawa, Flores, and Timor, and passes to the South of Sumba or Sandalwood Island.

The second cable goes from Singapore to Banjoewangie direct, and on again to Port Darwin. This cable goes to the north of all these islands, and lies in deep water. The greatest distance between the two cables is off Sunda Island, where they are about 100 miles apart.

The first cable was laid by the Eastern Extension Telegraph Co., unsubsidised, in 1871, and before the overland telegraph line to Port Darwin was finished; the messages being conveyed by horse express over the unfinished portion until the 21st of October, 1872, when through telegraphic communication was first established.

The advantage of rapid communication with the rest of the world was found to be so great that when interruptions occasionally occurred involving loss and inconvenience, the question of duplicating the cable was seriously considered, the result being that a second cable was laid between Singapore and Port Darwin in 1879 by the same company, the colonies of Victoria, South Australia, New South Wales, and Western Australia jointly paying, in proportion to their respective populations, an annual subsidy of £34,400 for a period of 20 years.

The conductor of the 1871 cable consists of seven stranded copper wires, of about No. 20 B.W. gauge each, surrounded with several layers of gutta-percha composition, forming the insulation. This is again encased in an armour consisting of iron wires, to protect and give the necessary strength to the cable. This is finally wound with hemp and asphalte. The shore ends of the cable are more heavily protected by very much thicker wires. The main cable is about 1in. in diameter, and weighs 3½ tons to the mile, while the shore ends weigh about 11½ tons per mile.

The 1879 cable is very similar, except that an intermediate size of cable is used, as well as the main and shore cable. The shore end of this cable weighs about 10 tons, intermediate 3½, and main 1¼ tons per mile. In this cable, between the gutta-percha core and the iron wires, brass tape is wound as a protection against the attacks of the teredo navalis, a little worm that bores through the gutta-percha, thereby destroying the insulation. These cables cost, roughly, about £100 per mile.

The system adopted for working is not the same as is used for ordinary telegraph lines, in which direct currents are transmitted. The submarine cable is analogous to an immense and attenuated Leyden jar, or condenser, the conductor being the inner, the sheath and water the outer coating, and the gutta-percha acting as the glass insulator. Thus the cable, so to speak, holds a charge of electricity, and by varying the amount and polarity of this charge, according to a preconcerted arrangement of signals, the messages can be signalled.

The instrument generally used on a long cable is Sir W. Thomson's syphon recorder, which consists of a coil of very fine wire, suspended between the poles of two powerful electro-magnets. Through this coil of wire the currents received travel. Fixed to this coil is a very fine glass syphon tube, which conducts the ink from the reservoir to a strip of paper drawn past the end of the glass tube at a uniform speed. Thus this glass pen records every movement of the coil to right or left. The suspended coil and tube will be attracted towards one electro-magnet or the other according to the polarity and strength of the current received. Thus, it will be easily understood how a code of signals can be made to represent the alphabet, as in the international code, letters are represented by movements of the coil and glass tube, which are recorded on the paper strip. Thus, A is represented by one movement to right and one to left. B one to the right, three to the left; C, one right one left, one right one left, and so on.

The speed of the instrument on the newest cables is about 18 words of five letters each per minute, but when worked duplex the rate is about doubled. Cable working is slow compared with the ordinary telegraph, which varies from 25 to 40 words when worked by hand, to from 200 to 1,000 per minute in various rapid automatic machines.

When a cable is broken, one way of finding the distance of the break is approximately as follows: The resistance which the entire length of the conductor of the cable offers to the passage of the electric current is known, and tests are usually taken each morning before work. The unit of resistance is called the "ohm." Thus the resistance of the 1879 cable is about 13,000 ohms, or about 11½ ohms per mile, in good condition. When the cable is broken and the inside conductor exposed, the current has not got to travel the entire length, but only as far as the break, and back by the iron sheathing and water, the resistance of which is taken as nil. The resistance is now much less, and from the testing instrument the number of ohms can be found, and as so many miles go to one ohm the number of miles distance of the fault is calculated. The matter is, however, not so simple, as various circumstances occur which interfere with the result. For instance, a small portion of the conductor may be exposed, a local current set up between the copper and iron wires in the sea water, polarisation, and other troubles.

To fish up the cable, a grapnel and stout wire rope is used, the

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steamer going slowly across the line of the cable, until it is caught, when it is hauled on board, examined, and repaired.

The course of telegraphic messages from Perth to London is as follows:

	Miles of Land Line.	Miles of Cable.	Total.
Perth-Albany	261	—	261
Albany-Eucla	762	—	752
Eucla-Port Augusta	759	—	759
Port Augusta-Alice Springs	1036	—	1036
Alice Springs-Port-Darwin	898	—	898
Port Darwin-Banjoewangie	—	1150	1150
Banjoewangie-Batavia	480	—	480
Batavia-Singapore	—	553	553
Singapore-Penang	—	399	399
Penang-Madras	—	1280	1280
Madras-Bombay	650	...	650
Bombay-Aden	—	1662	1662
Aden-Suez	—	1346	1346
Suez-Alexandria	224	—	224
Alexandria-Malta	—	828	828
Malta-Gibraltar	—	1008	1008
Gibraltar-Falmouth	—	1061	1061
Falmouth-London	350	—	350
	5,410	9,287	14,697

In the event of interruption of the cable connections at certain points of the regulated route, messages can be sent by way of Penang or Rangoon, or viâ Saigon, Bankok, and Tavoy (Burmah), or by the Indo-European Company's system, through Russia and across Europe, or by the Great Northern Company's system, across Siberia. This last route is as follows:

	Miles.
Singapore to Hong Kong	1876
Hong Kong to Shanghai	1265
Shanghai to Posiett Bay, Siberia	1380
Across Siberia and Russia, to Lieban, Baltic	6394
Lieban to New Beggin, England	1656
Total	12,571

The distance by the proposed route across Canada is approximately

Sydney to Vancouver, B. Columbia	8900
Across Canada	3400
Canada to Ireland	2450
Total	14,800

Messrs. Millar Bros.' proposed cable from the North-West Coast of Australia would be

N.W. Coast of Australia to Madras	3500
Madras to London	8409
	11,909

This would have the advantage of avoiding the volcanic regions through which both the present cables run.

The break in the cable communication may be caused by some of those violent volcanic disturbances which occur so frequently in the neighbourhood of the Malay Archipelago.

According to the latest test, the distance of the break is about 858 miles from Port Darwin on the old line, and on the new cable 898 miles. The commander of the "Myrmidon" reports that Mount Tomboro is in active eruption. This troublesome volcano is on the north side of Sumbawa Island. To the south of this island lie both cables, not very far apart. This point is, however, about 900 miles from Port Darwin, and about 200 miles from Banjoewangie. That the old cable was previously defective, and the new cable suddenly from some cause failed, thus cutting off all communication, is probably the most reasonable explanation.

If the cables are only broke in one place, a steamer would not take long to pick them up and repair the damage. But if much of the cable has been destroyed by violent disturbance over a considerable area (similar to what occurred in 1882 at Krakatoa) new pieces will have to be put in, and unless the cable steamers (one of which was reported to have been at Shanghai and the other at New Zealand) on their return have sufficient length to repair the damage, or unless a piece of the old cable is cut out, and spliced into the new one, or *vice versa*, some months may elapse before through telegraph communication will be restored.

But it is utterly impossible to foretell how long the break may last, as it depends on the damage, the cause of which we have no means of knowing at present, shut out as we are from the rest of the world.

The present cost of cablegrams from Perth to London is as follows:

Public message *via* Europe direct, 9s. 4d. per word of 10 letters; Cochin China, 12s 2d.; Hong Kong and Siberia, 15s. 1d.

During the year 1886, 46,667 messages to and from Australasia passed through the Port Darwin cables, representing £256,527, or an average per message of £5. 10s.

NEW COMPANIES REGISTERED.

Barnet and District Electric Supply Company, Limited.—Registered by Messrs. Ingledew, Ince, and Colt, of St. Benet-chambers, Fenchurch-street, with a capital of £5,000, divided into 490 ordinary shares of £10 each, and 100 founder's shares of £1 each. The object is to purchase all rights, benefits, &c., of Henry Francis Joel, under a contract of the Barnet Local Board, for the lighting of the district by electricity, and the supply of electricity to shops, &c. The first list of shareholders includes Mr. J. Ross, Basinghall-street; Mr. J. Palmer, Finsbury-square; and Mr. H. F. Joel, Wilson-street.

"Rees" Miners' Patent Safety Electric Lamp Company, Limited.—This Company has been registered to acquire, under an agreement already prepared and intended to be executed immediately after the incorporation of the Company, and to be made between John Price Rees of the one part, and Thomas M. Field, as trustee for the Company, of the other part, with such (if any) modifications as may be agreed upon certain letters patent obtained for the United Kingdom and elsewhere of the "Rees" Miners' Patent Safety Electric Lamp and the "Rees" Double Liquid Primary Battery and all future improvements, and any extension of the same. The capital of the Company is £50,000, divided into 10,000 shares of £5 each.

Bedford Electric Light Company, Limited.—Registered by Richard Jordan, 120, Chancery-lane, W.C., with a capital of £15,000, in shares of £1 each. Object: to enter into contracts for electric lighting, either alone or in conjunction with other means, and for the supply of electric energy for power or transmission, and for fixing, maintaining, sealing, hiring or otherwise dealing with transformers, wires, lamps, primary, secondary or storage batteries, and all other electrical appliances and equipments with any corporation or person, and to supply or manufacture, purchase or hire, take in, exchange or otherwise acquire, sell and supply all machinery, motors, generators, lamp materials, or appliances in connection with the production, transmission, storage and use by any means and any purpose of light and heat, and electric, magnetic or other force. The first subscribers are:

	Shares.
Sir H. Mance, Menora, Newnham-road, Bedford	1
T. Jessop, St. Paul's-square, Bedford	1
R. B. Stafford, Cauldwell House, Bedford	1
W. B. Jessop, 3, St. Paul's-square, Bedford	1
O. T. Christie, Hoddesden, Herts	1
T. Spencer, Ashburnham-road, Bedford	1
D. Bower, Springfield House, near Bedford	1

The number of Directors shall not be less than three, and the first Directors shall be appointed by the signatories to the memorandum of association. The qualification of every Director shall consist of his being the registered holder of 100 shares in the Company. By way of remuneration for their services the Directors shall be paid a yearly sum of £250, to be divided as the Directors may determine.

CITY NOTES.

West Coast of America Telegraph Company.—The receipts of the West Coast of America Telegraph Company for August amounted to £5,450.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ended August 21 amounted to £4,805.

Eastern Telegraph Company.—The Eastern Telegraph Company's traffic receipts for the month of August amounted to £43,703, and to £43,609 in the corresponding period of 1887.

Direct Spanish Telegraph Company.—The traffic receipts of the Direct Spanish Telegraph Company for the month of August amounted to £1,643, against £1,614 in the corresponding period of last year, showing an increase of £29.

Western and Brazilian Telegraph Company.—The traffic receipts of the Western and Brazilian Telegraph Company for the past week, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Company, were £3,991.

Eastern Extension, Australasia, and China Telegraph Company.—The traffic receipts of the Eastern Extension, Australasia, and China Telegraph Company for the month of August, 1888, amounted to £38,103, and to £36,274 in the corresponding period of 1887.

West India and Panama Telegraph Company.—The estimated receipts of the West India and Panama Telegraph Company for the half-month ended August 31, 1888, were £2,469, against £2,059 for the corresponding period of 1887. The May receipts, estimated at £5,793, realised £5,830.

PROVISIONAL PATENTS, 1888.

AUGUST 24.

12,198. **Improvements in electrical switches.** Frederick Thomas Schmidt, 27, Highfield-lane, Keighley, Yorkshire.

12,235. **Application of electricity to the lighting of road vehicles.** Francis Hazlett and John Hercules Percival, Gray's Inn Chambers, 20, High Holborn, London, W.C.

AUGUST 25.

12,264. **Improvements in the means of preparing metallic surfaces for the reception of non-adhesive electro deposits.** Francis Edward Elmore and Alexander Stanley Elmore, Armaside, Cockermouth.

12,289. **Improvements in electric propulsion on railways.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London, W.C.

12,290. **Improvements in galvanic batteries.** Alexander Schanschieff, 24, Southampton-buildings, London, W.C.

12,297. **Switchboard and handles.** Gustav Adolph Abrath, Borough-road, Sunderland, Durham.

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AUGUST 27.

12,309. **An improved rose for electrical purposes.** Edward William Johnstone, Bow Electric Works, Arnold-road, Bow, E.

12,332. **Improvements in electric meters.** Jules Cauderay, 24, Southampton-buildings, Chancery-lane.

AUGUST 28.

12,376. **Improvements in electric accumulators and in means for their manufacture.** William Lloyd Wise, 46, Lincoln's-inn-fields, London, W.C. (Jean Theodore Van Gestel, United States.)

12,383. **Improvements in electric arc lamps.** Charles Wells, 22, Southampton-buildings, Chancery-lane, W.C., Middlesex.

12,388. **Improvements in and relating to electrical signalling apparatus for domestic and other purposes.** Leslie Watt Winnall and William Howard Winnall, 4, South-street, Finsbury, London.

12,395. **Improvements in electro-therapeutic belts.** Alfred Julius Boult, 323, High Holborn, Middlesex. (Harry P. Pratt, United States.) (Complete specification.)

12,396. **Improvements in electric-motors for self-winding clocks.** William Phillips Thompson, 6, Lord-street, Liverpool. (Daniel W. Edgecomb, United States.) (Complete specification.)

12,409. **Improvements in effecting and controlling the feed of the carbons used in the arc lamps of electric "search lights" or "projectors."** Ronald Augustus Scott, 23, Andalus-road, Clapham, S.W.

AUGUST 29.

12,437. **Improvements in electrical conductors or cables.** William A. Conner and Joseph W. Marsh, 55 and 56, Chancery-lane, Middlesex. (Complete specification.)

12,446. **Improvements in electric telegraphs.** John Julius Ebel, Julia Cottage, Charlton-lane, Charlton, Kent.

12,452. **Improvements in electrical locomotives or traction engines.** Auguste Sandron, 323, High Holborn, Middlesex.

12,453. **Improvements in apparatus for hardening and tempering by electricity.** William Phillips Thompson, 6, Lord-street, Liverpool. (Philip Diehl, United States.) (Complete specification.)

12,455. **Improvements in the application of primary batteries and electro-motors to tricycles and other velocipedes.** John Sherrin and John Vaughan Sherrin, 77, Chancery-lane, London, W.C.

AUGUST 30.

12,505. **Improvements in joints for electric mains.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

OCTOBER 14, 1887.

13,960. **A novel combination of spring-jack and lightning arrester for use in or with a test-board for telephone wires and means of carrying, and a method of arranging, any required number of sets or apparatus formed of such combination; such invention being applicable also for the purpose of a telephone switch-board, and for other analogous electrical purposes.** Alfred Coleman and Hubert Feilden Jackson, 169, Fleet-street, London.

OCTOBER 22, 1887.

14,390. **An electric firing fuse or primer.** Richard Morris, 28, Southampton-buildings, Chancery-lane, London, W.C.

OCTOBER 25, 1887.

14,528. **Improvements in microphones.** Charles Bell, 96, Buchanan-street, Glasgow. (Lars Magnus Ericsson, Sweden.)

14,529. **Improvements in microphones.** Charles Bell, 96, Buchanan-street, Glasgow. (Lars Magnus Ericsson, Sweden.)

OCTOBER 28, 1887.

14,658. **Improvements in electric indicators.** George Edwin Fletcher, 93, Chatham-street, Edgeley, Stockport.

MAY 3, 1888.

6614. **Improvements in the electrical illumination of clock dials, and apparatus in connection therewith.** Ernest George Craven, 4, Little Moorfields, E.C.

JUNE 29, 1888.

9501. **An improved screw grip for adjustable lamp and other standards and for electric pendent lamps.** William Arthur Smith Benson, John Lovegrove, and Elie Hinton, trading as W. A. S. Benson and Co., 82, New Bond-street, London, W.

JULY 24, 1888.

10,691. **Improvements in or relating to electrical transmitting instruments.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.)

SPECIFICATIONS PUBLISHED.

1887.

10,663. **Electrical type-writers, &c.** A. J. Boult (McLaughlin.) 1s. 1d.

10,836. **Electrical firing mechanism for ordnance.** C. A. McEvoy. 8d.

11,928. **Indicating fire damp in coal mines, &c.** J. W. Swan. 8d.

12,880. **Producing solid metal sheets by electro-deposition.** W. J. Reynolds. 6d.

13,709. **Indiarubbor compensators for telegraph, &c., wires.** R. S. Bozon. 8d.

1888.

4659. **Making and breaking electrical circuits in connection with call boxes, &c.** F. T. Schmidt. 8d.

7848. **Indicators for alternating electric currents.** W. P. Thompson. (Westinghouse.) 8d.

7849. **Detecting and locating faults in alternate current electric circuits.** W. P. Thompson. (Westinghouse.) 8d.

7998. **Shades, &c., for incandescent electric lamps.** F. Holman. 8d.

8233. **Cylinder welding apparatus.** S. Pitt. (Rowland and Others.) 6d.

9206. **Galvanic elements.** C. Lutcke and P. George. 8d.

9331. **Relays.** F. Stitzel and C. Weinedel. 8d.

9660. **Electric-motors and dynamo machines.** A. J. Boult. (Lugo.) 1s. 1d.

9661. **Telephone transmitters.** A. J. Boult. (Emmner.) 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday.
2 July	4%	African Direct 4%	100	101
12 Feb.	1/2	Anglo-American Brush E.L.	4	8¼
12 Feb.	2/0	— fully paid	5	4¼
27 July	1%	Anglo-American	100	41½
27 July	2%	— Pref.	100	68¼
12 Feb., 85	5/0	— Def.	100	14
28 June	3/0	Brazilian Submarine	10	13⅛
14 June	1/0	Con Telephone & Main	1	1⅛
10 Aug.	9/0	Cuba	10	13¾x
10 Aug.	10/0	— 10% Pref.	10	19½
28 Mar.	2/2½	Direct Spanish	5	4
28 Mar.	5/0	— 10% Pref.	5	10½
27 July	2/0	Direct United States	20	9¼
27 July	4/6	Eastern	10	12¼
27 July	8/0	— 6% Pref.	10	15
1 Aug.	5%	— 5%, 1899	100	110
26 April	4%	— 4% Deb. Stock	100	108
12 July	2/6	Eastern Extension, Australasia & China	10	13¼
1 Aug.	6%	— 6% Deb., 1891	100	107
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	103
28 Mar.	8/3	German Union	10	9½
10 Aug.	3/0	Globe Telegraph Trust	10	6¾
10 Aug.	3/0	— 6% Pref.	10	14x
30 April	5/0	Great Northern	10	14
30 April	5%	Gt. Northern 5% Deb., '83.	100	109
27 July	10/0	India Rubber, G. P. & Tel.	10	17
11 May	37/6	Indo-European	25	39
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
		Swan United	3½	2¼
10 Aug.	13½%	Submarine	100	140x
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39½
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	8
1 Mar.	5%	— 5% Debs.	100	99
12 July	4/0	West Coast of America	10	7
30 June	8%	— 8% Debs.	100	115
11 May	9/0	Western and Brazilian	15	12¼
11 May	6/10½	— Preferred	7½	7
11 May	2/1½	— Deferred	7½	5¼
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	1⅜
30 May	10/0	— 6% 1st Pref.	10	12¼
13 May, '80		— 6% 2nd Pref.	10	9½
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	105

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NOTES.

Electric Cure.—A Kentucky doctor states that the actinic effect of exposure to the arc light is a cure for yellow fever.

The Garrick Theatre.—The new Garrick Theatre in Charing-cross-road is to be lighted by electricity on the most approved system of theatre lighting.

Harbour Lights.—The German harbour authorities are having some of the various harbour boats fitted with arc lights, for the purpose of illuminating the whole harbour at night.

Notice.—Owing to the number of British Association papers the continuation of the articles on "The Magnetic Field" and "The Young Electrician's Diary" will be held over for the present.

New Fibre.—The discovery is reported of a new fibre for filaments, which gives excellent results. The Companhia Lampada Braziliera has been formed in Rio Janeiro to work the patents.

Indian Telegraph. — Telegraphic communication between India and Europe, *vid* Egypt, has been restored, one of the Bombay-Aden cables of the Eastern Telegraph Company having just been repaired.

Electric Light v. Gas.—The Barnet Gas Company will reduce their price another 3d. per 1,000 feet from the 5th of January, 1889; but the electric light will not be stopped by sops of threepenny-pieces.

Tynemouth.—At the last meeting of the Tynemouth Town Council, it was resolved, by a majority of two to one, that application be made for a provisional order for lighting the borough with the electric light.

Prof. Ayrton's Lecture.—The lecture on "Transmission of Power," by Prof. Ayrton, has proved so interesting that, at the request of several working men, it was given over again on Thursday before a popular audience.

Versailles.—The town of Versailles is to be lighted by electricity by an electric light company having its station at Marly, seven miles away. A high tension current will be brought to Versailles and distributed by means of transformers.

The Telephone in China.—China is coming to the fore with the telephone. The Viceroy of Kouang and the Governor of Canton are having telephones put up between their offices. The Chinese are evidently going to make up for the time lost in the past.

Long Distance Telephony.—Telephonic communication was opened on Tuesday between Berlin and Breslau. The line is the longest in Germany, being 360 kilometres (about 220 miles). Every word was heard most distinctly in Berlin as well as in Breslau.

Fire Alarm Signals.—An electrical flash-light signal has been patented by Mr. William H. Thompson, of Richmond, Va. This invention is designed to provide a simple and efficient visual signalling apparatus for immediate use in cases of fire alarm or for police signals.

House-to-House Supply Company.—We are informed that the directors of this company have accepted the tender of Messrs. Peto Brothers for the erection of their first central electric lighting station at West Brompton. The building will be completed by the month of November.

Bristol.—The contract for the erection of electrical controlling apparatus and signals in connection with the machinery in a new granary built by the Docks' Committee of the Council of the city of Bristol, has been secured by Messrs. King, Mendham and Co., electrical engineers, of that city.

Death of Prof. Edlund.—Prof. Eric Edlund, member of the Royal Academy of Science of Sweden, died at Waxholm, near Stockholm, on the 19th of August last, in his 70th year. The celebrated Swedish professor contributed greatly to the knowledge of modern science in connection with electrical research.

Accumulator Cars.—An electric car, with one hundred storage cells placed under the seats, has been tested in Philadelphia by the Electric Car Company. The car was run 63 miles with one charging, but for ordinary work it is intended to charge every 40 miles run. The weight of motor and cells, &c., is 5,800lb., and the total weight of car 9,200lb.

Submarine Electric Vessel.—A submarine vessel, invented by Lieutenant Peral, of the Spanish Navy, was launched from the La Carraca Arsenal, Cadiz, on September 8. The vessel, which will be completed next month, is cylindrical in shape, and of 87 tons register, and is provided with twin screws, an electric engine, and a torpedo tube.

The B.T. System in Germany.—The small town of Dobhain is supplied with electric light on the battery system. The accumulators used are those of the Tudor type which we described some time since. Overhead wires are used, and the light is supplied for the same price as petroleum, the price being not much over a farthing per lamp an hour.

Castleford.—At the last ordinary meeting of the Castleford Local Board, in consequence of the gas company having positively declined to make any reduction in the price of gas supplied to the Board, it was resolved, on the recommendation of the Finance Committee, that the clerk make inquiries as to the feasibility and cost of providing a substitute for gas.

Strand District.—At the meeting of the Strand District Board of Works, on Wednesday, applications were received from the London Electric Supply Corporation, Limited, and the East Strand and District Electric Light and Power Company, Limited, for a license authorising the supply of electricity within the area of this district, and were referred to the Lighting Committee.

Sometimes Happens.—On the evening of the 30th ult. the whole of the city of Perth was plunged into darkness by the man in charge at the gas works turning off the wrong regulator. Moreover, although he turned it on again at once the light did not return, and the public gas-lighters had to go round again. The discomfort was great that night in Perth, and the smell of gas in the streets was alarming.

Percentage of Telephones.—London, with a population put at 4,765,000, contains only 4,193 subscribers to the telephone, while Stockholm, with a population of only 215,000, has 4,832 subscribers. Out of 12 of the principal cities of Europe, London stands last but two in telephone progress, the average of subscribers here being 0·9 per 1,000, as against 22·5 in Stockholm, 6·4 in Rome, 3·3 in Berlin, and 1·4 in Paris.

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Electrical Firedamp Indicator.—An automatic electrical firedamp indicator has been devised by M. Molas for the purpose of warning both the men in the mine and the engineers at pit's mouth. It is merely a system of electrical contact actuated by the upward pressure of the escaping gases. When these contacts are made bells are rung, and indicators lowered at the surface, and warning lamps are lit in the mine itself.

Paris-Marseilles Telephone.—This line has been open to the public since August 6. The method of procedure is as follows: The first half-hour in every hour is devoted to through communications from Paris to Marseilles; in the second half-hour Lyons and Paris are connected on one part of the line, and Lyons and Marseilles on the other. This method of alternate connection is kept up all day from seven in the morning till nine at night.

Six Thousand Telegraph Clerks Ready to Strike. According to the *Daily News* correspondent, great discontent is shown in Paris at the way in which promotion in the telegraph service is made. A meeting of over 500 telegraph clerks was held last Tuesday, and it was stated that 6,000 were ready to join them; a committee was formed to create a fund, and to enter into relations with the whole service, and was empowered to draw up a petition to the Postmaster-General.

Treatment of Copper Ore by Electricity in Spain.—M. Escozura, chief engineer of the Department of Mines in Spain, has invented a simple method of treatment of copper ore, by the electrolysis of a solution of sulphate of copper. By this means the production of pure copper is rendered extremely easy; 78 per cent. of the copper contained in the ore is recovered, and the price is very considerably reduced. The process is to be adopted in the Rio Tinto and Lagunazo mines.

A Sliding Scale for Gas.—The Sunderland Gas Company has adopted a somewhat amusing tariff, as under: For small consumers, 1s. 11d.; for consumers of 50,000 cubic feet, 1s. 10d.; above 300,000 cubic feet, 1s. 8d.; while *for those who might be thinking of lighting their places with electricity* the price would be 1s. 6d. nett only. They believed that, with these prices in operation, they would defy comparison with any gas concern in the country. We should imagine they were unique in all respects.

The Telpher System.—We are glad to see by Prof. Ayrton's paper that the telpher system is extending, and is also to be adopted in the Cornish mines. It has always appeared to us that in this system would be found a very good field of activity for enterprising engineers both in mining and in agriculture. There is a regular chain of progression in agriculture—from the spade to the barrow and from the barrow to the cart, but from the cart to the railway is too wide a jump. This hiatus it will be the place of the automatic electric railway to fill.

The Canary Islands.—The Spanish Government are now expending several hundred thousand pounds in improving their Canary Island possessions. The scheme includes the establishment of a line of mail and passenger steamers to run between the seven islands which form the group. The trial trip of the second steamer of the new line—the "Viera-y-Clavijo"—has just taken place on the Clyde. The "Viera-y-Clavijo" is a fine steel screw steamer of 620 tons. She is fitted in a most elaborate style for 150 passengers—first, second, and third class—and is fitted throughout with the electric light.

Electrical Treatment of Sewage.—Mr. Webster states that 25 h.p. will be required to treat one million gallons of sewage per day, with one grain of iron per gallon, representing probably for iron some six or eight shillings per million gallons. If the outfall of the weir or other water power could be utilised for the production of the electricity, a very great saving both in cost and in effectiveness of sewage treatment might be looked for. Municipalities who are at present debating sewage schemes are naturally anxious to know whether this process will be proved to be successful practically.

Colliery Lamps to be "Bonneted."—Mr. A. H. Stokes, F.G.S., H.M. Inspector of Mines for Derby, at the first annual meeting of the National Association of Colliery Managers held at Derby last week, said that it was generally understood that the lamp of the future would be a "bonneted" lamp, and he would suggest to them that once having settled their type they should let every part be made interchangeable. The last suggestion for those who make colliery lamps is admirable, whichever type survives; but we have great faith that the colliery lamp of the future will be an "electric" one rather than a "bonneted."

City Commission of Sewers.—At a meeting of the City Commissioners of Sewers, held at the Guildhall on Wednesday, an application was received from the East Strand and District Electric Light and Power Company for the Commissioners' consent to the application they are about to make to the Board of Trade for a provisional order, or license, to supply electricity in the portion of the City from Farringdon-street and New Bridge-street westward. This was referred to a committee, as was also an application from the London Electric Supply Corporation, for the Commissioners' consent to a licence being granted to them by the Board of Trade for the supply of electricity within the City.

Small Motors.—The advantage of a small and cheap engine always at hand is very apparent for many purposes, and the money-saving or money-producing power of small electro-motors must commend themselves to a great number of trading people as an additional reason for advocating the introduction of an electric circuit into their town. We should like to ask, Are our English manufac turers ready with a small, efficient, and neat-looking motor, suitable for sewing-machines, ventilating fans for rooms, coffee-grinding, knife-polishing, and organ-blowing? as, if not, we shall probably see our wants supplied, when central stations become more general, not by English, but by German or American firms.

Initials by Telephone.—All people who have occasion to telephone names have had great difficulty in making initials understood. B, C, D, E, G, P, T, and V sound so much alike that to distinguish between them is almost impossible, and M and N also sound very similar. A system used in a New Haven newspaper office for some time past, and with very satisfactory results, when the person at the other end of the wire has understood it, is to give a word beginning with the letter that is the initial in question. For instance, suppose the name is B. P. Smith. A score or more of other combinations have almost the same sound, but if the sender says "B. P. Smith; B for butter and P for pepper; B. P. Smith," there is no difficulty in understanding.

Overhead Travellers.—The applications of electric traction are pushing their way into commercial usefulness,

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and among these small railways for the disposal of heavy goods is an important one. Several applications of electric motors to trucks have been mentioned in conjunction with the ramification of a small electric railway throughout the grounds and buildings. In some cases where work of this kind has to be designed it may be useful to employ overhead rails constructed of iron girders, as a great saving of floor space is thus effected. A system of overhead travellers, with shunts and turntables constructed of iron girders, for use with the ordinary pulling gear, has been introduced by Messrs. Arnold, Goodwin and Son, of 56, Sumner-street, Southwark, and the same method might be advantageously employed when combined with electric motors for moving heavy goods.

The London Electric Supply Corporation.—The London Electric Supply Corporation are about to remove immediately to new and commodious offices at No. 3, Adelphi-terrace, Strand, their present offices at No. 79, Grosvenor-street being no longer sufficiently large for their rapidly-increasing business. The new central generating station of the corporation at Deptford is rapidly approaching completion, and it is understood that the directors will be able to furnish a largely-increased supply of the electric current before the close of the year. The factory and supply station together are some five acres in extent, and we understand the capital idea is to be carried out of imitating the example of the telegraph and carrying the leads into London along the railways. The supply is for 500,000 extra lights. The whole of the work is being carried out under the superintendence of Mr. Ferranti.

Municipal Manufacture of Electric Meters.—A good deal of comment has been made in the French technical papers with regard to the notice recently issued by the Municipal Council of Paris, respecting the prizes for electric meters which it has proposed to offer. It may be remembered that in this notice it is stated that "the city of Paris will reserve the right of manufacture of the prize meters without payment of further royalty." The happy receivers of the prize of £80 may perhaps, it is well suggested, not feel themselves so fully compensated by such a reward as to forego the profits of their invention, and enquiries are further made as to whether, if the "City of Paris" intends to add the manufacture of electric meters to its official duties, it may not also presently take to manufacturing dynamos, steam-engines, and other apparatus—a happy state of affairs for electric light *concessionaires* in Paris!

Electric Sugar.—The *Financial News* this week has a little boom of its own over Prof. Henry Friend's secret process of producing sugar. The shares of the Electric Sugar Company, it seems, have been ignored by the Stock Exchange, but the extraordinary rise from 21 to 104, we are told, has caused the wildest excitement in Liverpool. The *Financial News* publishes special cablegrams of the report of the experiments, similar to what we remember to have read several times before, and "without precautions against deception." It is fair to state that numerous persons have avowed themselves satisfied, and it is said that a plant is to be established capable of turning out 40 tons per hour of refined sugar, at a profit of £4 per ton, and with no waste in syrup. In the absence of details of the process, however, we must prefer to remain sceptical for the time, and shall soon enough be enlightened when we hear of a shipment of some of the "40 tons per hour" of best sugar arriving in Liverpool.

North Shields.—At a quarterly meeting of the Tynemouth Town Council, held at North Shields on Friday, Alderman Joseph Green moved that the Council make application for a provisional order for lighting the public buildings and streets of the borough with the electric light. This was the original idea at the time the present installation and electric light appliances were placed in the New Market. The power was there, and it was only economy to utilise it to its fullest extent. An amendment was moved that the question be remitted back to the committee for further consideration. Councillor Eskdale, in seconding the amendment, thought that to rush into reckless expenditure over additional electric light apparatus would not meet with the favour of the ratepayers. He contended that the scheme meant additional apparatus, and if the Council got this order they would not scruple to exceed their power in carrying the scheme to extremes. After a discussion, however, the resolution was carried by ten votes to five.

Proposal to Light Otley.—At the ordinary meeting of the Otley Local Board on Monday night (Mr. S. Arthur Duncan presiding) Mr. Johnson said that a firm of electric engineers had stated that the quantity of water running through Ellar Gill would be ample to supply power for the generation of electric light for the whole of Otley. As the Board had acquired the Ellar Gill property with the intention of converting it into a storage reservoir, and as the Local Government Board's inspector had condemned the site as unsuitable, it had been described as a "white elephant." Although it had been advertised, there seemed little likelihood of the Board letting the property to pay, and he thought if it could be utilised in the way suggested that would be the best plan to adopt, especially as it was said the town would be greatly benefited by the adoption of the electric light. The chairman said he was perfectly willing for the Board's property to be put to any useful purpose, and though he did not expect that the Ellar Gill would become a mine of wealth in affording electric light, he had no objection to inquiring into the practicability of the proposal. After further discussion, a sub-committee was appointed to obtain information on the subject, and to report to the Board at its next meeting.

Maritime Telegraphing.—M. A. Banaré has communicated to the French Academy of Sciences the result of some experiments in submarine telephony he has undertaken in the harbour of Brest, by order of the Minister of Marine, on August 2 to 13, with the aid of an apparatus he has named the "hydrophone." In these experiments the sounds produced under water by means of various sounding instruments, bell, whistle, or trumpet, have been able to be transmitted under the water; those of a bell weighing 300lb. were easily perceived at all distances allowed by the conformation of the harbour, so as to avoid sandbanks or promontories between apparatus and the point of emission of the signals. The greatest of these distances was 5,200 metres (3½ miles), and the sounds were quite clear and distinct. An official commission was appointed to test the action of the submarine apparatus as compared with the direct sound of a whistle with a moving steamer with very good results, the submarine signals being heard beyond the latter to a distance of one mile. The sound of the bell was always heard with great clearness, in spite of the noise of the machinery and of the screw. Details of the apparatus are not given, and it is not clear, although M. Banaré uses the word telephony, whether the apparatus used is an electric telephone. The field of enquiry is, however, a profitable one, and we are

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glad to see responsible persons taking the matter up seriously.

Conversazione at All Saints' Works, Derby.—On Friday evening last Messrs. John Davis and Son, the well-known manufacturers of mining apparatus, of All Saints' Works, Derby, entertained the National Association of Colliery Managers (who were holding their first annual meeting in that town) at a conversazione at the new and commodious premises lately erected by the firm, mainly, we believe, in connection with the large development of their electric lighting business. For the purposes of the conversazione, the premises had been extemporised into a delightful combination of an exhibition of scientific apparatus with the lighter pleasures of a social gathering. The broad staircase was carpeted with crimson cloth and tastefully adorned with choice plants and flowers, as, indeed, were the premises throughout. A brilliant programme of music was arranged and choice refreshment *ad libitum* was supplied, under the shade of palms and hot-house ferns, for the mental and physical delectation of the members of the association. The whole of the premises were magnificently lighted with the electric light, and exhibits were shown comprising the very complete electric lighting apparatus of the firm, which included a large arc (the size to be used for street lighting) of 1,000 c.p.; a "Castle" arc lamp, of 500 c.p., suitable for smaller area; a "Sunbeam" incandescent lamp of 150 c.p.; and a number of incandescent lights of the usual 16 c.p. The dynamo used was that known as the "Castle," of 70-light capacity. The results were entirely satisfactory. Messrs. Davis may be congratulated as being the first to satisfactorily demonstrate the excellence and adaptability of the electric light in Derby.

Berlin.—The following description is given by the Berlin correspondent of *Industries*, of the installation of arc lamps in Unter-den-Linden, Berlin. The street contains a promenade of 18yds. width in the centre, a way for heavy traffic on one side, and an avenue for riders on the other. On either side of these are carriageways for light traffic, and finally the footways. The total width of the street between the house fronts is about 190ft. As there are four avenues of trees dividing the five ways, it was not feasible to light the whole of the space effectively from the two sides, and the lamps have, therefore, been arranged in three rows. Altogether, there have been erected 116 lamps, distributed over a distance of about a mile and a quarter. The side lamps are suspended from handsome iron standards with curved tops, and the centre lamps over the promenade from chains stretched between iron posts on either side, so as to leave the whole width of the promenade unobstructed by poles. In order to prevent the suspended lamps from swaying in the wind, the suspending chains are stiffened by diagonal wrought-iron stays attached to the posts. The base of the lamp-post is attached by bolts to a foundation-plate placed 5ft. under the level of the pavement, and the counterweight for the lamp slides up and down within the post. Current is supplied to the lamps by flexible cables carried half-way up the posts, and then passing outside up to the lamps, and a switch is placed in each lamp-post. The lamps are lowered in the usual way for trimming, but when drawn up they rest tightly against an upper casing and reflector of german silver, so as to prevent their swaying about. The globes are of opal glass.

The International Tramway Congress.—At the International Tramway Congress, held at Brussels on September 8, the question of electric traction was brought forward by M. Michelet, the chairman of the Brussels Tramway Company, who gave his experience with the accumulator system, and explained its use on the Brussels tramways. At the beginning the faulty dimensions of the accumulators caused their speedy deterioration. The plates have been made larger and less heavy, and instead of lead, as in the beginning, they are made now of an alloy of lead, antimony, and mercury. The Brussels Tramway Company watches carefully the expenditure for this service. Each battery of accumulators has a special account, to which 10 centimes for every kilometre which has been run is allowed, and a comparison of the results of these accounts is regularly made. A car runs from 100 to 110 kilometres a day. One year at least of the keeping of these accounts, also monthly inventories, are required to determine the cost of the service. M. Michelet considered it safe to predict that very important improvements will be made shortly, his company having received offers from various inventors. For the moment, however, notwithstanding the savings which have been realised in the installation of the dynamos, in the transmission and working expenses, traction by electricity on the Brussels lines continues to be more expensive than animal traction. The afternoon was devoted to a visit to the installations for electrical traction of the Brussels Tramway Company, the examination of the steam-cars (system Rowan) in use on the line Brussels-Schepdael, which belongs to the National Company of Vicinal Railways, and to an excursion to Schepdael. The International Tramway Congress decided to hold its next meeting at Milan in September next year.

"Electric Tramway Systems" Terminology.—A short time since we gave in our columns the report of Mr. Kapp upon the Lineff Tramway System. The criticism of our excellent contemporary, the *Electrical Review*, in its issue of September 7 upon this report, leads us to ask if some common ground cannot be found whereby to designate the proposed or experimental schemes of inventors, patentees, and promoters. Mr. Kapp is called to task because he styles Mr. Lineff's work the "Lineff System." We cannot see the objection to such a term, nor do we think that "arrangement" is to be preferred. In what does an "arrangement" differ from a "system," and how are we to distinguish the one from the other. It may be that the "arrangement" or "system" proposed does not commend itself to the critics, but, for goodness sake, do not let us begin to split hairs in such a fashion as this. We suppose that Mr. Kapp, as an electrical engineer of repute, was employed in the ordinary way to make a report. So far as we know, neither Mr. Kapp nor Mr. Lineff were cognisant of our having a copy of this report, or with our intention of publishing it; therefore we are, in a measure, answerable for having paved the way for these critical remarks. With the opinions as to the value of the system we have nothing to do, except that we cannot undertake to agree to all the conclusions of our contemporary, and especially as to the absolute similarity between Profs. Ayrton and Perry's "arrangement," "scheme," "design," "system," "combination," or whatever word we use to designate it, and that of Mr. Lineff. It might, however, be again pointed out that Mr. Kapp's estimates were based upon figures obtained by a dual trial. The desire to push ahead in electric traction is so universal among engineers, that favourable and unfavourable criticism should be welcomed, as all tends to bring us towards a starting point of agreement.

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ELECTRIC DOG-CART FOR THE SULTAN OF TURKEY.

Messrs. Immisch and Co. have had for some little time a mysterious piece of work in hand, the nature of which was known to the initiated as being an electric dog-cart to be constructed to the order of H.M. the Sultan of Turkey. On Wednesday last a number of persons were invited to inspect this automatic vehicle, now completed, and to personally test its running in the Camden Skating Rink, Camden-road.

The appearance of the electric dog-cart is shown by the accompanying illustration. In appearance it is similar to an ordinary four-wheeled dog-cart, but without the shafts. In use the running is very easy and perfectly under control, but it must be said the absence of shafts and a horse gives it at first to the mind of the onlooker a curious, imperfect appearance, comparable to seeing a fowl running about without its head; this effect, no doubt, wears off, but it will be probable, if electric dog-carts come much into use, that a special form of carriage adapted to the needs of accumulators instead of horses will evolve, as the Pullman car has superseded the early railway imitation of the stage coach.

The origin of the idea of the electric dog-cart is due to Mr. Magnus Volk, of Brighton, who constructed an electric dog cart some years ago, and it was the sight or fame of this vehicle that induced the Sultan to give an order for one for his own private use. This order has been entrusted to Messrs. Immisch, in conjunction with Mr. Volk, who have taken advantage of the experience gained with the previous vehicle, and have added several improvements, so that they now believe there is nothing more to be done in the way of making its running a complete success. The dog-cart is constructed with a walnut body and white wood spokes, brightly varnished, and the cushions and hangings are of a harmonious brown colour, and are embroidered with the Turkish Imperial crest—the star and crescent; it is beautifully finished, but, although destined for an Oriental Court, has not been designed to have any specially luxurious appearance.

The motive power is supplied by a set of 24 small E.P.S. accumulators, placed in the body of the cart, of sufficient storage capacity to drive the dog-cart for five hours at the speed of 10 miles an hour. The weight of the accumulators is 7cwt., and that of the carriage, all complete, is 11½cwt.

The motor is Messrs. Immisch and Co.'s 1 h.p. type, using in this case a current of 20 to 25 amperes, with an E.M.F. of 48 volts. When the vehicle is running at a speed of 10 miles an hour, the motor makes 1,440 revolutions per minute, and develops ¾ actual h.p. The motor is connected to one of the wheels by means of a chain, as shown, gearing into a sprocket wheel on the motor shaft. The ratio of gearing of motor to driving wheel is about 18 to 1; the circumference of the wheel being 10ft. 9in. On an ordinary road the amount of work required, of course, varies with the uphill or downhill gradient, and the total amount of work done is thus, on an average, about the same as on level road. The current required to start is about 25 amperes, and for very heavy gradients as much as 45 or 50 amperes could be taken for a few minutes without harm. The motor has been tested up to 90 amperes.

The dog-cart carries four persons; it is started, stopped, and guided without any difficulty by means of a switch with three resistances, and a steering gear fitted to the fore-carriage, with a handle for the driver. The cost is

Electric Dog-Cart made by Messrs. Immisch for the Sultan of Turkey.

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£200. Rather a rattling noise is made by the commutators and sprocket wheels, but this is said to be not noticeable on ordinary road above the noise of the wheels. One improvement we should suggest before sending away, and that is, that a small actual make-and-break connection should be inserted in the circuit in some safe place under a catch to act as a safeguard, which could be disconnected when the cart is not in use; otherwise the Sultan's ostler might have the astonishing spectacle (if he happened to give the switch-handle an unexpected knock) of seeing the electric dog-cart spin off on a tour by itself, running down several Mussulmen, knocking them over, and drenching them with battery solution.

The experiments made on Wednesday were very successful, many persons enjoying a ride, and the vehicle was under the complete control of Mr. Volk. Messrs. Immisch may be complemented on having produced a really serviceable electric carriage, not merely a king's toy; and we shall expect to see very important developments in commercial usefulness result from their continued work upon the Sultan's electric dog-cart.

THE BRITISH ASSOCIATION.

ADDRESS TO THE MECHANICAL SCIENCE SECTION BY WILLIAM HENRY PREECE, F.R.S., M.I.C.E., ETC., PRESIDENT OF THE SECTION.

(Concluded from page 199.)

In our Central Savings Bank in London it has been found, after two years' experience of electric lighting, that the average amount of absences from illness has been diminished by about two days a year for each person on the staff. This is equivalent to a gain to the service of the time of about eight clerks in that department alone. Taking the cost at the "overtime" rate only, this would mean a saving in salaries of about £640 a year. The cost of the installation of the electric light was £3,349, and the annual cost of working £700 per annum, say a total annual cost of £1,034. The cost of the gas consumed for lighting purposes was about £700 a year, so that on the whole there was a direct saving of something like £266 a year to the Government, besides the material advantage of the better work of the staff resulting from the improved atmospheric conditions under which their work is done.

The production of light by any means implies the consumption of energy, and this can be measured in *watts*, or the rate at which this energy is consumed. A watt is $\frac{1}{746}$ part of a *horse-power*. It is a very convenient and sensible unit of power, and will, in time, replace the meaningless horse-power.

One candle-light maintained by	tallow	absorbs	124	watts.
,, ,,	wax	,,	94	,,
,, ,,	sperm	,,	86	,,
,, ,,	mineral oil	,,	80	,,
,, ,,	vegetable oil	,,	57	,,
,, ,,	coal gas	,,	68	,,
,, ,,	cannel gas	,,	48	,,
,, ,,	electricity (glow)	,,	3	,,
,, ,,	electricity (arc)	,,	0·5	,,

The relative heat generation of these illuminants may be estimated from these figures.

Though the electric light was discovered by Davy in 1810, it was not until 1844 that it was introduced into our scientific laboratories by Foucault; it was not until 1878 that Jablochkoff and Brush showed how to light up our streets effectually and practically; it was not until 1881 that Edison and Swan showed how our homes could be illuminated softly and perfectly. Unpreparedness for such a revolution produced a perfect panic among gas proprietors; inexperience in the use of powerful electric currents resulted in frequent failure and danger; speculation in financial bubbles transferred much gold from the pockets of the weak to the coffers of the unscrupulous; hasty legislation in 1882 restricted the operations of the cautious and the wise; and the prejudice arising from all these causes has, perhaps fortunately, delayed the general introduction of electricity; but now legislation has been improved, experience has been gained, confidence is being restored, and in this beautiful town of Bath fifty streets are about to be lighted, and we see everywhere around and about us in our English homes the pure glow lamp replacing filthy gas and stinking oil. The economical distribution of the electric current over large areas is annually receiving a fresh impetus. The expensive systems defined in the Act of Parliament of 1882 have entirely disappeared. Hopkinson in England and Edison in America showed how a third wire reduced the weight of copper needed by 66 per cent. Gaulard and Gibbs in 1882 showed how the conversion of alternate currents of high E.M.F. to currents of low E.M.F. by simple induction coils would enable a mere telegraph wire to convey sufficient electricity to light a distant neighbourhood economically and efficiently. Lane Fox, in 1879, showed how the same thing could be done by secondary batteries; and Planté, Faure, Sellon, and Parker have done much to prove how batteries can be made to solve the problem of storage, while King and Edmunds have shown how the distribution by secondary batteries can be done as economically as by secondary generators. The Grosvenor Gallery Company in London have proved the practicability of the secondary generator principle by nightly supplying 24,000 glow-lamps scattered over a very wide area of London. The glow-lamp of Edison, which in 1881 required 5 watts per candle, has been so far improved that it now consumes but 2½ watts per candle. The dynamo, which in the same year weighed 50,000lb., absorbed about 150 h.p., and cost £4,000 for 1,000 lamps, now weighs 14,000lb., absorbs 110 h.p., and costs £500 for the same production of external energy—in other words, its commercial output has been increased nearly six times, while its prime cost has been diminished eight times.

The steam-engine has received equal attention. The economy of the electric light when steam is used depends almost entirely on the consumption of coal. With slow-speed, low-pressure engines, one kilo-watt (1,000 watts, 1⅓ h.p.) may consume 12lb. of coal per hour; in high-speed, high-pressure triple-expansion engines, it need not consume more than 1lb. of coal per hour. Willans and Robinson have actually delivered from a dynamo one kilo-watt by the consumption of 2lb. of coal per hour, or by the condensation of 20lb. of steam.

There is a great tendency to use small economical direct-acting engines in place of large expensive engines, which waste power in countershafting and belts. Between the energy developed in the furnace in the form of heat, and that distributed in our rooms in the form of light, there have been too many points of waste in the intermediate operations. These have now been eliminated or reduced. Electricity can now be produced by steam at 3d. per kilo-watt per hour. The kilo-watt hour is the Board of Trade unit as defined by the Act of 1882, for which the consumer of electric energy has to pay. Its production by gas-engines costs 6d. per kilo-watt hour, while by primary batteries it costs 3s. per kilo-watt hour. The Grosvenor Gallery Company supply currents at 7½d. per kilo-watt hour; a 20 c.p. lamp, consuming 3 watts per candle, and burning 1,200 hours per annum, expends 82,000 watt hours, or 82 kilo-watt hours, and it costs, at 7½d. per unit, 50s. per annum. If the electricity be produced on the premises, as is the case in the post office in the House of Commons, and in many large places, it would cost 20s. 6d. per annum. I have found from a general average under the same circumstances and for the same light in the General Post Office in London, that an electric glow-lamp costs 22s. and a gas-lamp 18s. per annum. The actual cost of the production of one candle light per annum of 1,000 hours is as follows:—

	s.	d.
Sperm candles	8	6
Gas (London)	1	3
Oil (petroleum)	0	8
Electricity, glow	0	9
,, arc	0	1½

The greatest development of the electric light has taken place on board ship. Our Admiralty have been foremost in this work. All our warships are gradually receiving their equipment. Our ocean going passenger ships are also now so illumined, and, perhaps, it is here that the comfort, security, and true blessedness of the electric light is experienced.

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Railway trains are also being rapidly fitted up. The express trains to Brighton have for a long time been so lighted, and now several northern railways, notably the Midland, are following suit. Our rocky coasts and prominent landmarks are also having their lighthouses fitted with brilliant arc lamps, the last being St. Katherine's Point on the Isle of Wight, where 60,000 candles throw their bright beams over the English Channel, causing many an anxious mariner to proceed on his way rejoicing.

Fontaine showed in Vienna, in 1873, that a dynamo was reversible—that is, if rotated by the energy of a moving machine, it would produce electric currents; or, if rotated by electric currents, it would move machinery. An electric current is one form of energy. If we have at one place the energy of falling water, we can, by means of a turbine and a dynamo, convert a certain portion of the energy of this falling water into an electric current. We transmit this current through proper conductors to any other place we like, and we can again, by means of a motor, convert the energy of the current into mechanical energy to do work by moving machinery, drawing tramcars, or in any other way. We can in this way transmit and utilise 50 per cent. of the energy of the falling water wherever we like. The waste forces of Nature are thus within our reach. The waterfalls of Wales may be utilised in London; the torrents of the Highlands may work the tramways of Edinburgh; the wasted horse-power of Niagara may light up New York. The falls of Bushmills actually do work the tramway from Portrush to the Giant's Causeway, and those of Bessbrook the line from Newry to Bessbrook.

The practicability of the transmission of energy by currents is assured, and the economy of doing this is a mere matter of calculation. It is a question of the relative cost of the transmission of fuel in bulk, or of the transmission of energy by wire. Coal can be delivered in London for 12s. per ton. The mere cost of the upkeep of a wire between Wales and London to deliver the same amount of energy would exceed this sum tenfold. For long distances the transmission of energy is at present out of the question. There can be no doubt, however, that for many purposes within limited areas the transmission of energy by electricity would be very economical and effective. Pumps are worked in the mines of the Forest of Dean, cranes are moved in the works of Easton and Anderson at Erith, lifts are raised in banks in London, water is pumped up from wells to cisterns in the house of Sir Francis Truscott, near East Grinstead; ventilation is effected, and temperature lowered in colleries; goods, minerals, and fuel can be transmitted by telpherage.

The transmission of power by electricity is thus within the range of practice. It can be distributed during the day by the same mains which supply currents for light by night. Small industries, such as printing, watch-making, tailoring, bootmaking, can be cheaply supplied with power. It is thus brought into direct competition with the distribution of power by steam as in America, or by air-pressure as in Paris, or by high-pressure water as in London; and the relative advantages and economies of each system are simple questions of calculation. When that evil day arrives that our supply of natural fuel ceases, then we may look to electricity to bring to our aid the waste energies of Nature—the heat of the sun, the tidal wave of the ocean, the flowing river, the roaring falls, and the raging storm.

There is a mode of transport which is likely to create a revolution in the method of working tramways. A tramcar carries a set of accumulators which supplies a current to work a motor geared to a pair of wheels of the car. The weight, price, day's work, and life of the accumulator is curiously the same as the weight, price, day's work, and life of horseflesh; but the cost of maintenance, the liability to accident, and the chances of failure are much less. Although very great improvements in batteries have been made, and they are now really practical things, sufficient experience in tramcar working has not yet been obtained to say that we have reached the proper accumulator. Nor have we yet acquired the best motor and mode of gearing; but very active experiments are being carried out in various countries, and nothing can prevent their ultimate success.

The property, which the electric current possesses, of doing work upon the chemical constitution of bodies so as to break up certain liquid compounds into their constituent parts, and marshal these disunited molecules in regular order according to a definite law upon the surfaces of metals in contact with the liquid where the current enters and exists, has led to immense industries in electro-metallurgy and electro-plating. The extent of this industry may be gathered from the fact that there are 172 electro-platers in Sheffield and 99 in Birmingham. The term electro-metallurgy was originally applied to the electro-deposition of a thin layer of one metal on another; but this is now known as electro-plating.

In 1839 Jacobi in St. Petersburg and Spencer in Liverpool laid the foundations of all we know of these interesting arts. Copper was deposited by them so as to obtain exact reproductions of coins, medals, and engraved plates. The first patents in this country and in France were taken out by Messrs. Elkington, of Birmingham, who still occupy the foremost position in the country.

The fine metals, gold and silver, are deposited in thin layers on coarser metals, such as german silver, in immense quantities. Christofle, of Paris, deposits annually six tons of silver upon articles of use and of art, and if the surfaces so electro-plated were spread out continuously they would cover 140 acres.

The whole of the copper plates used in Southampton for the production of our splendid ordnance survey maps are deposited by copper on matrices taken from the original engraved plates, which are thus never injured or worn, are always ready for addition or correction, while the copies may be multiplied at pleasure and renewed at will.

Nickel-plating, by which the readily oxidisable metals like iron are coated with a thin layer of the more durable material nickel, is becoming a great industry; the trappings of harness, the exposed parts of machinery, the fittings of cycles and carriages, and innumerable articles of daily use are being rendered not only more durable but more beautiful.

The electro-deposition of iron, as devised by Jacobi and Klein, in the hands of Prof. Roberts-Austen, F.R.S., is giving very interesting results. The dies for the coins which were struck at our Mint on the occasion of the Jubilee of the Queen were modelled in plaster, reproduced in intaglio by the electro-deposition of copper, and on these copper moulds hard excellent iron in layers of nearly $\frac{1}{10}$th of an inch was deposited.

The exact processes of measurement, which have led to such vast improvement in our telegraphic systems, have scarcely yet penetrated into this field of electrical industry, and little is known at present of the exact relations of current and E.M.F. with respect to surfaces of contact, rate of deposit, and resistance of liquids. Captain Sankey, R.E., of the Ordnance Survey Department, has done some useful work in this direction.

The extraction of metals from their ores by deposition has received wide application in the case of copper. In 1871 Elkington proposed to precipitate copper electrolytically from the fused sulphide of copper and iron known to the copper smelter as "regulus." Thin copper plates were arranged to receive the deposited copper while the foreign metals, including gold and silver, fell to the bottom of the solution, the process being specially applicable, it was supposed, to regulus containing small quantities of the precious metals.

The electrical purification of copper from impure "blister copper" or "blade copper" has also made great progress, and special dynamos are now made which will, with an expenditure of 100 h.p., precipitate 18 tons of copper per week. The impure metal is made to form the anode in a bath of sulphate of copper, the metal being deposited in the pure form on a thin copper cathode.

It was not very long ago considered very economical to absorb ·85 h.p. in depositing one pound of copper per hour, but now the same work can be done with ·3 h.p. Mr. Parker of Wolverhampton, has done good work in this direction, and his dynamos in Messrs. Bolton's works have revolutionised this process of purification.

Both at Swansea and Widnes, immense quantities of copper, in spite of the restrictive operations of the copper syndicate, are being produced by electro-deposition. Copper steam-pipes for boilers are now being built up of great firm-

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ness, fine texture, and considerable strength by Mr. Elmore, at Cockermouth, by electro-deposition on a rotating mandril in a tank of sulphate of copper. By this process one ton of copper requires only a little more than one ton of coal to raise the requisite steam to complete the operation.

It has been shown that the electrolytic separation of silver from gold by similar methods is perfectly practicable. The value of the material to be dealt with may be gathered from the fact, communicated to the Gold and Silver Commission, now sitting, that nearly 90,000,000 ounces of silver are annually produced, and the greater portion of this amount contains sufficient gold to render refining remunerative. Although the old acid process of "parting" gold and silver remains practically undisturbed, there seems no reason to doubt that in the future electricity will render us good service in this direction as it has already in the purification of copper.

There is not much actual progress to report in the extraction of gold from its ores by electrical agency. The conversion of gold into chloride of gold by the direct, or indirect, action of chlorine is employed on a very large scale in [Grass Valley] California and elsewhere. This fact has led to well-directed efforts to obtain by electrolytic action, chlorine which should attack finely-divided gold suspended (with the crushed ore) in the solution from which the chlorine was generated, the gold, so converted into soluble chloride, then being deposited on a cathode. The process would seem to be hopeful, but is not as yet a serious rival to the ordinary chlorination method.

In the amalgamation of gold ores, much is expected from the possibility of keeping clean, by the aid of hydrogen set free by the electric current, the surfaces of amalgamated plates.

It is well known that the late Sir W. Siemens considered that the electric arc might render good service in the fusion of metals with high melting points, and he actually succeeded in melting 96 ounces of platinum in ten minutes with his electrical furnace. The experiments were interrupted by his untimely death, but in the hands of Messrs. Cowles the electric arc produced by 5,000 amperes and 500 h.p. is being employed on a very large scale for the isolation of aluminium (from corundum), which is immediately alloyed *(in situ)* with copper or iron, in the presence of which it is separated.

The heating power of large currents has been used by Elihu Thomson in the United States, and by Bernardos in Russia, to weld metals, and it is said to weld steel without affecting its hardness. It has even been proposed to weld together in one continuous mass long length of the rails of our railways so as to dispense to a great extent with joints.

The production of chlorine for bleaching and of iodine for pharmaceutical purposes, the economical production of oxygen, are also processes now dependent on the electrolytic effect of the electric current.

It is almost impossible to enumerate the various general purposes to which electricity is applied to minister to our wants, and to add to our comforts. Everyone appreciates the silent efficiency of the trembling electric bell, while all will sooner or later derive comfort from the perennially self-winding electric clock. Correct mean time is distributed throughout the length and breadth of the land by currents derived from Greenwich Observatory. Warehouses and shops are fitted with automatic contact pieces, which, on any undue increase of temperature due to fire, create an alarm in the nearest fire station; and at the corner of most streets a post is found with a face of glass, which on being broken enables the passer-by or the watchful and active policeman to call a fire engine to the exact spot of danger. Our sewers are likely to find in its active chemical agency a power to neutralise offensive gases, and to purify poisonous and dangerous fluids. The germs of disease are attacked and destroyed in their very lairs. The physician and the surgeon trust to it to alleviate pain, to cure disease, to effect organic changes beyond the reach of drugs. The photographer finds in the brilliant rays of the arc lamp a miniature sun which enables him to pursue his lucrative business at night, or during the dark and dismal hours of a black November fog of London.

We learn from the instructive and interesting advertising columns of our newspapers that "electricity is life," and we may perhaps read in the more historical portion of the same paper that by a recent decision of the New York Parliament, "electricity is death." It is proposed to replace hanging by the more painless and sudden application of a powerful electrical charge; but those who have assisted at this hasty legislation would have done well to have assured themselves of the practical efficacy of the proposed process. I have seen the difficulty of killing even a rabbit with the most powerful induction-coil ever made, and I know those who escaped and recovered from the stroke of a lightning discharge.

The fact that the energy of a current of electricity, either when it flashes across an air space, or when it is forced through high resistance, assumes the form of heat of very high temperature, led early to its employment for firing charges of gunpowder; and for many civil, military, and naval purposes it has become an invaluable and essential agent. Wrecks, like that of the "Royal George" at Spithead, were blown up and destroyed; the faces of cliffs and quarries are thrown down; the galleries of mines and tunnels are excavated; obstructions to navigation, like the famous Hell Gate, near New York, have been removed; time guns, to distribute correct time, are fired by currents from Greenwich at 1 p.m. In the operations of war, both for attack and defence, submarine mining has become the most important branch of the profession of a soldier and a sailor. Big guns, whether singly or in broadside, are fired, and torpedoes, when an enemy's ship unwittingly is placed over them, are exploded by currents of electricity.

An immense amount of research has been devoted to design the best form of fuse, and the best form of generator of electricity to use to explode them. Gun tubes for firing consist of a short piece of very fine wire embedded in some easily fusible compound, while the best form of fuse is that known as the Abel fuse, which is composed of a small, compact mass of copper phosphide, copper sulphide, and potassium chlorate. The practice in the use of generators is very various. Some, like the Austrians, lean to the high tension effects of static electricity; others prefer magneto machines; others use the dynamo; while we in England cling with much fondness to the trustworthy battery. Since the electric light has also become such a valuable adjunct to war purposes, it is probable that secondary batteries will become of immense service. The strong inductive effects of atmospheric electricity are a source of great danger. Many accidental explosions of fuses have occurred. An experimental cable with a fuse at one end was laid below low-water mark along the banks of the Thames at Woolwich. The fuse was exploded during a heavy thunderstorm. The knowledge of the causes of a danger is a sure means for the production of its removal, or of its reduction to a minimum. Low-tension fuses and metallic circuits reduce the evils of lightning, but have not removed them. Should war unhappily break out again in Europe, submarine mining will play a very serious part, and, paradoxical as it may appear—as has been suggested by the French ambassador, M. Waddington—its very destructiveness may ultimately prove it to be a powerful element of peace.

It seems incredible that, having utilised this great power of nature to such a wide and general extent, we should be still in a state of mental fog as to the answer to be given to the simple question, What is electricity? The engineer and the physicist are completely at variance on this point. The engineer regards electricity, like heat, light, and sound, as a definite form of energy, something that he can generate and destroy, something that he can play with and utilise, something that he can measure and apply. The physicist—at least, some physicists, for it is difficult to find any two physicists that completely agree with each other—regard electricity as a peculiar form of matter permeating all space as well as all substances together with the luminiferous ether which it permeates like a jelly or a sponge. Conductors, according to this theory, are holes or pipes in this jelly, and electrical generators are pumps that transfer this hypothetical matter from one place to another. Other physicists, following Edlund, regard the ether and electricity as identical, and some, the disciples of Helmholtz, consider it as an integral constituent of nature, each molecule of matter having its own definite charge, which determines its

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attraction and repulsion. All attempts to revive the Franklinian or material theory of electricity have, however, to be so loaded with assumptions, and so weighted with contradictions, that they completely fail to remove electricity from the region of the mysterious. It is already extremely difficult to conceive the existence of the ether itself as an infinitely thin, highly elastic medium, filling all space, employed only as the vehicle of those undulatory motions that give us light and radiant heat. The material theory of electricity requires us to add to this another incomprehensible medium embedded or entangled in this ether, which is not only a medium for motion, but which is itself moved. The practical man, with his eye and his mind trained by the stern realities of daily experience, on a scale vast compared with that of the little world of the laboratory, revolts from such wild hypotheses, such unnecessary and inconceivable conception, such a travesty of the beautiful simplicity of Nature.

He has a clear conception of electricity as something which has a distinct objective existence, which he can manufacture and sell, and something which the unphilosophic and ordinary member of society can buy and use. The physicist asserts dogmatically: "Electricity may possibly be a form of matter—it is not a form of energy." The engineer says distinctly: "Electricity is a form of energy—it is not a form of matter; it obeys the two great developments of the present generation—the mechanical theory of heat, and the doctrine of the conservation of energy." There must be some cause for this strange difference of views. It is clear that the physicist and the engineer do not apply the term electricity to the same thing. The engineer's electricity is a real form of energy; the speculative philosopher's electricity is a vague subjective unreality, which is only a mere factor of energy, and is not energy itself. This factor, like force, gravity, life, must, at any rate for the present, remain unknowable. It is not known what force is; neither do we know what is matter or gravity. The metaphysician is even doubtful as regards time and space. Our knowledge of these things commences with a definition. The human mind is so unimpressionable, or language is so poor, that writers often cannot agree even on a definition. The definition of energy is capacity for doing work. We practical men are quite content to start from this fiducial line, and to affirm that our electricity is something which has a capacity for doing work; it is a peculiar form of energy. The physicist may speculate as much as he pleases on the other side of this line. He may take the factors of energy, and mentally play with them to his heart's content; but he must not rob the engineer of his term *electricity*. It is a pity that we cannot settle our difference by changing the term. Physicists might leave the term *electricity* to the form of energy, which is an objective reality, and which the ordinary mortal understands; while engineers would be quite content if speculative physicists and enthusiastic mathematicians would call their subjective unreality, their imaginary electrical matter, by some other term. If it be necessary to mentally create some imaginary matter to fulfil the assumptions and abstractions of their mathematical realisations, let them call it *coulombism* or *electron*, and not appropriate the engineer's generic and comprehensive term electricity. The engineer finds the motions of existing matter and of the ether quite sufficient to meet all his requirements, and to account for all those phenomena which are called electrical.

It seems paradoxical to assert that two unrealities can form a reality, or that two subjective ideas can become an objective one; but it must be remembered that in all electrical phenomena that which makes them real and objective is derived from without. The motion that renders an electrical phenomena evident is imparted to it from some other form of energy. The doctrine of the conservation of energy asserts that energy is never destroyed, it is only transformed—work must be done to render it evident. No single electrical effect can be adduced which is not the result of work done, and is not the equivalent of energy absorbed. The engineer's notion of work—something done against resistance; and of power—the rate at which this change of condition is effected—are the keystones to the conception of the character of those great sources of power in Nature whose direction to the uses and convenience of man is the immediate profession of those who generally assemble together in Section G of the British Association to discuss the "practical application of the most important principles of natural philosophy which has, in a considerable degree, realised the anticipations of Bacon and changed the aspect and state of affairs in the whole world."

I cannot pretend to have given a survey of all the practical applications of electricity. I have but briefly indicated the present area covered by the new and rapidly-growing industry. Five million people upon the globe are now dependent on the electric current for their daily bread. Scarcely a week passes without some fresh practical application of its principles, and we seem to be only on the shore of that sea of economy and beneficence which expands with every new discovery of the properties of electricity, and spreads already beyond the mental grasp of any one single worker.

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION BY PROF. G. F. FITZGERALD, M.A., F.R.S., PRESIDENT OF THE SECTION.

The British Association in Bath, and especially we here in Section A, have to deplore a very great loss. We confidently anticipated profit and pleasure from the presence in this chair of one of the leading spirits of English science, Dr. Schuster. We deplore the loss and we deplore the cause of it. It is always sad when want of strength makes the independent dependent, and is doubly sad when a life's work is thereby delayed; and to selfish humanity it is trebly sad when, as in this case, we ourselves are involved in the loss. And our loss is great. Dr. Schuster has been investigating some very important questions. He has been studying electric discharge in gases, and he has been investigating the probably allied question of the variations of terrestrial magnetism. We anticipated his matured pronouncements upon these subjects, and also the advantage of his very wide general information upon physical questions, and the benefit of his judicial mind while presiding here.

As to myself, his substitute, I cannot express how much gratified I feel at the distinguished honour done me in asking me to preside. It has been one of the ambitions of my life to be worthy of it, and I will do my best to deserve your confidence; man can do no more, and upon such a subject "the less said the soonest mended."

I suppose most former occupants of this chair have looked over the addresses of their predecessors to see what sort of a thing was expected from them. I find that very few had the courage to deliver no address. Most have devoted themselves to broad general questions, such as the relation of mathematics to physics, or more generally deductive to inductive science. On the other hand, several have dealt each with his own speciality. On looking back over these addresses my attention was specially arrested by the first two past presidents of this section, whose bodily presence we cannot have here. They were presidents of Section A in consecutive years. In 1874 Provost Jellett occupied this chair, and in 1875 Prof. Balfour Stewart occupied it. Both have gone from us since the last meeting of this association. Each gave a characteristic address. The Provost, with the clearness and brilliancy that distinguished his great intellect, plunged through the deep and broad questions surrounding the mechanism of the universe, and with impassioned earnestness claimed on behalf of science the right to prosecute its investigations until it attains, if it ever does attain, to a mechanical explanation of all things. This intrepid honesty to carry to their utmost the principles of whose truth he was convinced, the utter abhorrence of the shadow of double-dealing with truth, was eminently characteristic of one whom all, but especially we of Trinity College, Dublin, will long miss as a lofty example of the highest intellectual keenness and honesty, and mourn as the truest-hearted friend, full of sympathy and Christian charity. In 1875 Professor Stewart gave us a striking example of the other class of address in a splendid exposition of the subject he did so much to advance, namely, solar physics. He brought together from the two great storehouses of his information and speculation a brilliant store, and displayed them here for the advancement of science. Him, too, all science mourns. Though, from want of personal acquaintance, I am unequal to the task of bringing before you his many abilities and great character, you can each compose a fitting epitaph for this well-known great one of British science. In this connection I am only expressing what we all feel when I say how well-timed was the Royal bounty recently extended to his widow. At the same time the niggardly recognition of science by the public is a disgrace to the enlightenment of the nineteenth century. What chancellor or general with his tens of thousands has done that for his country and mankind that Faraday, Darwin, and Pasteur have done? The "public" now are but the children of those who murdered Socrates, tolerated the persecution of Galileo, and deserted Columbus.

In a presidential address on the borderlands of the known delivered from this chair, the great Clerk-Maxwell spoke of as an undecided question whether electro-magnetic phenomena are due to a direct action at a distance or are due to the action of an intervening medium. The year 1888 will be ever memorable as the year in which this great question has been experimentally decided by Hertz in Germany, and, I hope, by others in England. It has been decided in favour of the hypothesis that these actions take place by means of an intervening medium. Although there is nothing new about the question, and

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although most workers at it have long been practically satisfied that electro-magnetic actions are due to an intervening medium, I have thought it worth while to try and explain to others who may not have considered the problem what the problem is and how it has been solved. A presidential address such as this is not for specialists; it is for the whole section; and I would not have thought of dealing with this subject only that its immediate consequences reach to all the bounds of physical science.

We are all familiar with this, that when we do not know all about something they are generally a variety of explanations of what we do know. Whether there is anything of which there are in reality a variety of explanations is a deep question which some have connected with the freedom of the will, but which I am not concerned with here. A notable example of the possibility of a variety of explanations for us is recorded in connection with an incident said to have occurred in the neighbouring town of Clifton, where a remarkable meteorological phenomenon, as it appeared to an observing scientist, was explained by others as a bull's-eye lantern in the hands of Mr. Pickwick. Another kind of example is the old explanation of water rising in a pump, that "Nature abhors a vacuum," as compared with the modern one. Nowadays, when we know as little about anything, we say, "It is the property of electricity to attract." This is really little or no advance on the old form, and is merely a way of stating that we know a fact, but not its explanation. There are plenty of cases still where a variety of explanations is possible. For example, we know of no *experimentum crucis* to decide whether the people I see around me are conscious or are only automata. There are other questions which have existed, but which have been experimentally decided. The most celebrated of these are the questions between the caloric and kinetic theories of heat, and between the emission and undulatory theories of light. The classical experiments by which the case has been decided in favour of the kinetic theory of heat and the undulatory theory of light are some of the most important experiments that have ever been performed. When it was shown that heat disappeared whenever work appeared, and *vice versa*, and so the caloric hypothesis was disproved; when it was shown that light was propagated more slowly in a dense medium than in a rare, the sciences of light and heat were revolutionised. Not but that most who studied the subject had given their adhesion to the true theory before it was finally decided in general estimation. In fact, Rumford and Davy's experiments on heat, and Young and Fresnell's experiments on light, had really decided these questions long before the erroneous views were finally abandoned. I hope that science will not be so slow in accepting the results of experiment in respect of electro-magnetism as it was in the case of light and heat, and that no Carnot will throw back science by giving plausible explanations on a wrong hypothesis. Rowland's experiment proving an electro-magnetic action between electric charges depending on their absolute and not relative velocities has already proved the existence of a medium relative to which the motion must take place, but the connection is rather metaphysical and is too indirect to attract general attention. The importance of the striking experiments was that they put the language of the wrong hypothesis out of fashion. Elementary text-books that halted between two opinions, and, after the manner of text-books, leant towards that enunciated in preceding text-books, had all perforce to give prominence to the true theory, and the whole rising generation began their researches from a firm and true standpoint. I anticipate the same results to follow Hertz's experimental demonstration of a medium by which electro-magnetic actions are produced. Text-books which have gradually been invoking lines of force, in some respects to the aid of learners and in others to their bewilderment, will now fearlessly discourse of the stresses in the ether that cause electric and magnetic cause. The younger generation will see clearly in electro-magnetic phenomena the working of the all-pervading ether, and this will give them a firm and true standpoint for further advances.

And now I want to spend a short time in explaining to you how the question has been decided. An illustrative example may make the question itself clearer, and so lead you to understand the answer better. In colloquial language we say that balloons, hot air, &c., rise because they are light. In old times this was stated more explicitly, and therefore much more clearly. It was said that they possessed a quality called "levity." "Levity" was opposed to "heaviness." Heaviness made things tend downwards, levity made things tend upwards. It was a sort of action at a distance. At least it would have required such a hypothesis if it had survived until it was known that heaviness was due to the action of the earth. I expect levity would have been attributed to the direct action of heaven. It was comparatively recently in the history of mankind that the rising of hot air, flames, &c., was attributed to the air. Everybody knew that there was air, but it was not supposed that the upward motion of flames was due to it. We now know that this and the rising of balloons are due to the difference of pressure at different levels in the air. In a similar way we have long known that there is an ether, an all-pervading medium, occupying all known space. Its existence is a necessary consequence of the undulatory theory of light. People who think a little but not much sometimes ask me, "Why do you believe in the ether? What's the good of it?" I ask them, "What becomes of light for the eight minutes after it has left the sun and before it reaches the earth?" When they consider that they observe how necessary the ether is. If light took no time to come from the sun there would be no need of the ether. That it is a vibratory phenomenon, that it is affected by matter it acts through—these could be explained by action at a distance very well. The phenomena of interference would, however, require such complicated and curious laws of action at a distance as practically to put such a hypothesis out of court, or else be purely mathematical expressions for wave propagation. In fact, anything except propagation in time is explicable by action at a distance. It is the same in the case of electro-magnetic actions. There were two hypotheses as to the causes of electro-magnetic actions. One attributed electric attraction to a property of a thing called electricity, to attract at a distance, the other attributed it to a pull exerted by means of the ether, somewhat in the way that air pushes balloons up. We do not know what the structure of the ether is by means of which it can pull, but neither do we know what the structure of a piece of india-rubber is by means of which it can pull, and we might as well ignore the indiarubber, though we know a lot about the laws of its action, because we do not know its structure, as to ignore the ether because we do not know its structure. Anyway, what was wanted was an experiment to decide between the hypothesis of direct action at a distance and of action by means of a medium. At the time that Clerk-Maxwell delivered his address no experiment was known that could decide between the two hypotheses. Specific inductive capacity, the action of intervening matter, the delay in telegraphing, the time propagation of electro-magnetic actions by means of conducting material—these were known, but he knew that they could be explained by means of action at a distance, and had been so explained. Waves in a conductor do not necessarily postulate action through a medium such as the ether. When we are dealing with a conductor and a thing called electricity running over its surface, we are, of course, postulating a medium on or in the conductor, but not outside it, which is the special point at issue. Clerk-Maxwell *believed* that just as the same air that transmits sound is able by differences of pressure—*i.e.*, by means of its energy per unit volume—to move bodies immersed in it, so the same ether that transmits light causes electrified bodies to move by means of its energy per unit volume. He believed this, but there was no experiment known then to decide between this hypothesis and that of direct action at a distance. As I have endeavoured to impress upon you, no *experimentum crucis* between the hypotheses is possible except an experiment proving propagation in time, either directly or indirectly, by an experiment exhibiting phenomena like those of the interference of light. A theorist may speak of propagation of actions in time without talking of a medium. This is all very well in mathematical formulæ, but, as in the case of light, we must consider what becomes of it after it has left the sun and before it reaches the earth, so every hypothesis assuming action in time really postulates a medium whether we talk about it or not. There are some difficulties surrounding the complete interpretation of some of Hertz's experiments. The conditions are complicated, but I confidently expect that they will lead to a decision on most of the outstanding questions on the theory of electro-magnetic action. However, there is no doubt that he has observed the interference of electro-magnetic waves quite analogous to those of light, and that he has proved that electro-magnetic actions are propagated in air with the velocity of light. By a beautiful device Hertz has produced rapidly-alternating currents of such frequency that their wave length is only about two metres. I may pause for a minute to call your attention to what that means. These waves are propagated three hundred thousand kilometres in a second. If they vibrated three hundred thousand times a second the waves would be each a kilometre long. This rate of vibration is much higher than the highest audible note, and yet the waves are much too long to be manageable. We want a vibration about a thousand times as fast again with waves about a metre long. Hertz produced such vibrations, vibrating more than a hundred million times a second. That is, there are as many vibrations in one second as there are seconds—in a day? No, far more. In a week? No; more even than that. The pendulum of a clock ticking seconds would have to vibrate for four months before it would vibrate as often as one of Hertz's vibrators vibrates in one second. And how did he detect the vibrations and their interference? He could not see them; they are much too slow for that; they should go about a million times as fast again to be visible. He could not hear them; they are much too quick for that. If they went a million times more slowly they would be well heard. He made use of the principle of resonance. You all understand how by a succession of well-timed small impulses a large vibration may be set up. It explains many things, from speech to spectrum analysis. It is related that a former Marquis of Waterford used the principle to overturn lamp-posts; his ambition soared above knocker-wrenching. So that it is a principle known to others besides scientific men. Hertz constructed a circuit whose period of vibration for electric currents was the same as that of his generating vibrator, and he was able to see sparks, due to the induced vibration, leaping across a small air-space in this resonant circuit. The well-timed electrical impulses broke down the air-resistance just as those of my Lord of Waterford broke down the lamp-post. The combination of a vibrating generating circuit with a resonant-receiving circuit is one that I spoke of at the meeting of the British Association at Southport as one by which this very question might be studied. At the time I did not see any feasible way of detecting the induced resonance; I did not anticipate that it could produce sparks. By its means, however, Hertz has been able to observe the interference between waves incident on a wall and the reflected waves. He placed his generating vibrator several wave lengths away from a wall, and placed the receiving resonant circuit between the generator and the wall, and in this air-space he was able to observe that at some points there were hardly any induced sparks; but at other and greater distances from his generator they reappeared, to disappear again in regular succession at equal intervals between his generator and the wall. It is exactly the same phenomenon as what are known as Lloyd's bands in optics, which are due to the interference between a direct and a reflected wave. It follows hence that, just as Young's and Fresnell's researches on the interference of light prove the undulatory theory of optics, so Hertz's experiment proves the ethereal theory of electro-magnetism. It is a spendid result. Henceforth, I hope no learner will fail to be impressed with the theory—hypothesis no longer—that electro-magnetic actions are due to a medium pervading all known space, and that it is the same medium as the one by which light is propagated, that non-conductors can, and probably always do, as Prof. Poynting has taught us, transmit electro-magnetic energy. By means of variable currents, energy *is* propagated into space with the velocity of light. The rotation of the earth is being slowly stopped by the diurnal rotation of its

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magnetic poles. This seems a hopeful direction in which to look for an explanation of the secular precession of terrestrial magnetism. It is quite different from Edlund's curious hypothesis that free space is a perfect conductor. If this were true, there would be a pair of great antipoles outside the air, and terrestrial magnetism would not be much like what it is, and I think the earth would have stopped rotating long ago. With alternating currents we *do* propagate energy through non-conductors. It seems almost as if our future telegraph cables would be pipes. Just as the long sound waves in speaking-tubes go round corners, so these electro-magnetic waves go round corners if they are not too sharp. Prof. Lodge will probably have something to tell us on this point in connection with lightning conductors The silvered glass bars used by surgeons to conduct light are exactly what I am describing. They are a glass, a non-conducting, and therefore transparent, bar surrounded by a conducting, and therefore opaque, silver sheath, and they transmit the rapidly alternating currents we call light. There would not be the same difficulty in utilising the energy of these electro-magnetic waves as in utilising radiant heat. Having all the vibrations of the same period, we might utilise Hertz's resonating circuits, and in any case the second law of thermodynamics would not trouble us when we could practically attain to the absolute zero of these, as compared with heat, long period vibrations.

We seem to be approaching a theory as to the structure of the ether. There are difficulties from diffusion in the simple theory that it is a fluid full of motion, a sort of vortex sponge. There were similar difficulties in the wave theory of light owing to wave propagation round corners, and there is as great a difficulty in the jelly theory of the ether arising from the freedom of motion of matter through it. It may be found that there is diffusion, or it may be found that there are polarised distributions of fluid kinetic energy which are not unstable when the surfaces are fixed ; more than one such is known. Osborne Reynolds has pointed out another, though in my opinion less hopeful, direction in which to look for a theory of the ether. Hard particles are abominations. Perhaps the impenetrability of a vortex would suffice. Oliver Lodge speaks confidently of a sort of chemical union of two opposite kinds of elements forming the ether. The opposite sides of a vortex ring might perchance suit, or maybe the ether, after all, is but an atmosphere of some infra-hydrogen element. These two latter hypotheses may both come to the same thing. Anyway, we are learning daily what sort of properties the ether must have. It must be the means of propagation of light ; it must be the means by which electric and magnetic forces exist; it should explain chemical actions, and, if possible, gravity.

On the vortex-sponge theory of the ether there is no real difficulty by reason of complexity why it should not explain chemical actions. In fact, there is every reason to expect that very much more complex actions would take place at distances comparable with the size of the vortices than at the distances at which we study the simple phenomena of electro-magnetism. Indeed, if vortices can make a small piece of a strong elastic solid we can make watches and build steam-engines and any amount of complex machinery, so that complexity can be no essential difficulty. Similarly, the instantaneous propagation of gravity, if it exists, is not an essential difficulty, for vortices each occupy all space, and they act on one another simultaneously everywhere. The theory that material atoms are simple vortex rings in a perfect liquid otherwise unmoving is insufficient, but with the innumerable possibilities of fluid motion it seems almost impossible but that an explanation of the properties of the universe will be found in this conception. Anything purporting to be an explanation founded on such ideas as "inherent property of matter to attract," or building up big elastic solids out of little ones, is not of the nature of an ultimate explanation at all; it can only be a temporary stopping place. There are metaphysical grounds, too, for reducing matter to motion and potential to kinetic energy.

These ideas are not new, but it is well to enunciate them from time to time, and a presidential address in Section A is a fitting time. Besides all this, it has become the fashion to indulge in quaint cosmical theories, and to dilate upon them before learned societies and in learned journals. I would suggest, as one who has been bogged in this quagmire, that a successor in this chair might well devote himself to a review of the cosmical theories propounded within the last few years. The opportunities for piquant criticism would be splendid.

Returning to the sure ground of experimental research, let us for a moment contemplate what is betokened by this theory that in electro-magnetic engines we are using as our mechanism the ether—the medium that fills all known space. It was a great step in human progress when man learnt to make material machines, when he used the elasticity of his bow and the rigidity of his arrow to provide food and defeat his enemies. It was a great advance when he learnt to use the chemical action of fire; when he learnt to use water to float his boats and air to drive them; when he used artificial selection to provide himself with food and domestic animals. For two hundred years he has made heat his slave to drive his machinery. Fire, water, earth, and air have long been his slaves, but it is only within the last few years that man has won the battle lost by the giants of old, has snatched the thunderbolt from Jove himself and enslaved the all-pervading ether.

CORRESPONDENCE.

"FLATS" ON COMMUTATOR.

To the Editor of The Electrical Engineer.

Sir,—I conclude from the tone of Mr. Wallis's letter in your last issue that he rather questions the soundness of my explanation of the cause of "flats" on commutators. The explanation I gave was not, of course, intended to apply to all cases, but simply to the one in question. I think it quite possible that among the sixty bars of copper, of which the commutator is built up, two might be softer than the rest. Even if they were all of an equal degree of hardness in the first instance, is it not likely that in brazing on the tail-pieces the surfaces of some of the bars might be rendered soft, and thus wear more rapidly than the others? Before trying to explain the cause of the "flat" in this way, I had examined all the armature connections and found them perfect. Mr. Wallis attributes the cause to "a defective connection of those segments to the armature, producing, by the resistance it introduces, a greater difference of potential across that particular section than its share of the total."

Now, I fail to see how the fact of a greater difference of potential being produced across a particular section than its proper share causes the two bars of the commutator corresponding to that section to wear flat. Perhaps Mr. Wallis will enlighten me? I think also that Mr. Wallis confounds the action of a motor with that of a dynamo. In the former, the current flowing produces a difference of potential across each section of the armature directly proportional to its resistance. In the dynamo the reverse is the case; it is the E.M.F. generated by the cutting of magnetic lines of force which produces the current, and therefore, if a defective connection introduces an extra resistance in any coil, I cannot see that the E.M.F. of that coil would be increased. It appears to me (but I am open to correction) that its current would be reduced. Again, is it not the fact that, if the brushes are properly set, the coil passing them is in the position of least activity, and therefore generating no E.M.F. at all?

But what about the defective connections that Mr. Wallis has "invariably found"? May I suggest that these were not *causes*, but *effects*? Effects, perhaps, of the high temperature to which the defective bars had been raised.—Yours, &c.,

Broad Bent.

London, September 11, 1888.

PERMANENT MAGNETS.

To the Editor of The Electrical Engineer.

Sir,—Can any of your readers state the practical *modus operandi* of manufacturing permanent magnets? Certain makers of steel profess to supply metal of the best quality for the purpose.

What is the proper heat to raise the steel before shaping the magnets? What portion of the magnet should be tempered, and to what degree of temper? What is the best system of magnetising?

A reply from one or more of your technical readers will much oblige.—Yours, &c.,

S. Z.

September 12, 1888.

Telephone Recorder.—The following particulars are given of a telephone recorder, invented by Edward C. Paramore, Philadelphia, of the American National Telephone Company, of New York, with the assistance of Mr. Bonta, inventor of the Bonta telephone. The inventors have been working on the device for the past four years, and have at last reached what they consider perfection in its construction. The arrangement is contained in a small box, which is placed in proximity to the telephone and connected by wire. No name has yet been given it. A person is called upon the telephone, and, if not present, the person speaking continues talking, the communication being electrically committed to wax paper within the machine. When the person addressed arrives at the other end of the wire, he notices that a ball has dropped on the apparatus, which indicates that someone has been talking. Going to the telephone he opens the switch, when all that has been said previously by the person at the other end of the line commences to be heard in precisely the same tone of voice and at the same rate of speed. The sheets of paper are 8in. by 11in., and can at any time be placed in the machine and the sound be reproduced.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

THE B.A., 1888.

Elsewhere we give a complete list of the electrical papers read at the Bath meeting of the British Association. The full text of the papers or a sufficiently full abstract will in due course be given in our columns, and thus our readers will be able to form their own opinions as to the scientific or practical value of the meeting, and may take to heart the lessons to be learned therefrom. There really does seem some grounds for the jubilation apparent in Section A, which gave rise to an opinion expressed with increasing fervour to the close of the meeting, that the year's proceedings will mark the commencement of an epoch in the history of electrical investigation. Prof. Hertz's experiments, which formed the text of Prof. Fitzgerald's address to the section, supplemented as they were by experiments carried out by Prof. Lodge, have opened out to the mind of the physicist a vision beautiful to contemplate, a new field of research, a field hitherto untrodden, and therefore unexplored. The ear takes cognisance of sound waves, the eye of light waves. The former are comparatively slow, the latter tread upon the other extreme. Between the two lies an unexplored region, and it is into this region that the experiments of Hertz and Lodge take us. Prof. Fitzgerald, at the Southport meeting, hinted at the possibility of exploring this region, and suggested that the electric current might furnish the means. Prof. Lodge, not content with describing his experiments, has ventured to point out the possibilities that environ practical applications in the prosecution of the researches into this new field. It is well known, he pointed out, that ordinarily to obtain those vibrations which produce the sensation of light, a vast number of other vibrations are generated which are not required, and the cost of producing the light waves is enormously increased by having to perform this extra work. He forsees, dimly it may be, the possibility of getting rid of the steam-engine and the dynamo as wasteful, and, with our perfected knowledge, useless accessories in the product of light. A small boy turning a handle is to produce the necessary vibrations. Perhaps, however, the steam-engine will be of some use to replace a few hundreds of these small boys. It will be seen that Prof. Lodge aims to produce light waves only. Of course, if such an idea is ever realised, it will revolutionise our present systems of lighting, though manufacturers need take no alarm, for, even if the proverb that threatened men live long, failed, the business of the manufacturer would remain in the construction of the new forms of apparatus required. It is only the few who can conceive the realisation of these hopes, for the many can only understand that, so far as they are concerned, direct commercially useful transformations are almost unknown. Passing from what may be termed the most important scientific

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question of the meeting, we should instance as one of the most interesting to practical men the paper of Messrs. Lowrie-Hall-Kolle for the measurement of alternate currents supplied to consumers. These gentlemen propose a system which has been satisfactorily tried at Eastbourne for nine months past. In the converter circuit they place a depositing cell and a secondary battery cell, the latter having practically a constant E.M.F. of two volts. During one-half the period the E.M.F. of the converter circuit acts with that of the accumulator, and during the other half against it. This causes, supposing the E.M.F. of the converter circuit to be 100 volts, a deposition during the half period in the depositing cell from a current under an effective voltage of 102 volts, while the reverse action reducing the deposit is due to a current under a voltage of 98 volts. The deposit therefore is equivalent to a deposit during the whole period of working of a current with E.M.F. of two volts. The deposit due to one hour's working being known, it only remains to divide the weight of the total deposit by this unit, and the number of hours total working is known. The result is—time that the current has been employed. The arrangement is very ingenious, but there are many objections to its use on a large scale. The multiplication of terminals necessary in the connections of the cells is one weak point, the constant supervision of the cells is another, and though one almost blushes to refer to it, yet taking the world as it is, cheating the producer would be rendered an excessively easy affair. Either the depositing cell or accumulator would be short-circuited out of practical existence so far as the time measurement is concerned. But our readers will have an opportunity of reading the paper and deciding for themselves the value of the suggestion for work upon a large scale.

The Bath meeting was not to pass without new suggestions to mechanical and electrical nomenclature. The Committee on Mechanical Nomenclature suggest the use of the terms *Kine*, *Bole*, and *Barad*, thus:—

1 cm. per sec. = 1 kine.
1 gramme kine = 1 bole.
1 dyne per sq. cm. = 1 barad.

The Committee on Electrical Standards, at the request of Mr. Preece, recommend the adoption of the term *Therm* as the amount of heat required to raise one gramme of pure water one degree centigrade at the temperature of maximum density, and *Joule* as the work done by a watt per second.

The uncouthness of some of these terms was put forward as a reason for their adoption, as their unfamiliarity would compel closer attention and lead to their being easily remembered.

We have thus briefly mentioned what we take to be the salient features of the meeting, but there is one other subject to which reference must be made. Some people go to the sections to read, and some to hear papers, others seem to go for no earthly object whatever except it be to move about as noisily as possible at the most inconvenient moments. The clumsy clod-hopper could hardly make more noise in the village "pub." than do some men in moving into or out of the meeting rooms. They are either stupidly ignorant or so intensely conceited that they cannot understand the harm they do. The same remarks apply to the evening meetings. The moment the lecturer has ceased, the hall begins to be somewhat of a bear-garden. No matter the eminence of the mover and seconder of the vote of thanks, no matter how opportune the remarks they have to make, a considerable part of the audience rush for the doors, and render it impossible for those who wish to hear comfortably. If the B.A. is to be looked upon in the light of a picnic, by all means let it be so, but even at a picnic courtesy is not unknown, and it would seem desirable to discuss in Section F some such paper as "Courtesy to speakers at modern meetings."

ELECTRICAL PAPERS AT THE BRITISH ASSOCIATION.

The following is a complete list of the papers on electrical subjects read at the British Association:

Section A.

Prof. F. G. FITZGERALD, M.A., F.R.S.—President's Address.
Prof. W. STROUD and W. W. HALDANE GEE.—"Electro-Calorimetry."
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ON RECENT DEVELOPMENTS OF THE COWLES' ALUMINIUM PROCESS.*

BY R. E. CROMPTON.

It is unnecessary to again describe the earlier stages of the Brothers Cowles' invention of the electric furnaces. I confine myself to a description of such parts of the new plant which has been recently put down at Milton, near Stoke-on-Trent, that I think will be of general scientific interest.

The experience in America at the works at Lockport, Ohio, showed conclusively that great economies were to be expected from increasing the size of the furnaces and the strength of the electric current employed to work them, but no current larger than 3,000 amperes had been used up to the time that the Milton works were planned.

Mr. Eugene Cowles came over to England to ascertain whether English makers of dynamo machines were prepared to supply one sixty per cent. larger than Mr. Brush's "Colossus," which had been made especially for them in America, and which was then the largest direct current machine in the world. He prepared his specification for a dynamo to give a current of 5,000 amperes at 60 volts, and eventually Messrs. Crompton's design and tender were accepted. The works were built near the Milton station on the North Staffordshire Railway. The boilers for generating the steam required are of the Babcock-Wilcox type, and are provided with mechanical stokers. The steam-engine is of 600 h.p., and is a compound condensing horizontal tandem, made by Messrs. Pollit and Wigzel, of Sowerby Bridge. It is furnished with an exceedingly perfect centrifugal governor, which maintains the speed accurately at seventy-six revolutions in spite of very great fluctuations in the load. The electrical means of stopping the engine have been provided in the shape of Tate's electrical stop valve, which may be described as an electro-magnet arrangement, with the ordinary pushes for completing the circuit, which actuates a steam relay piston set to close the main stop valve. The fly-wheel of this engine is 20ft. in diameter, and weighs 30 tons, and is geared to the pulley of the dynamo, so that the latter makes five revolutions for every revolution of the engine by rope driving gear, consisting of eighteen ropes. This engine is an extremely fine specimen of a modern steam-engine. It works so silently that a visitor standing in the engine-house with his back to the engine railings at the time the engine is being started cannot tell whether it is in motion or not. The dynamo at first sight seems very small when compared with the steam-engine driving it; the fact is that it is dwarfed by the enormous fly-wheel of the engine. It is only when one stands close to the plummer block bearings that one realises the great size of the spindle and of all the parts required to transmit the power to the armature coils. The author was well aware when designing this machine that the mechanical strains on the spindle core attachments and winding were likely to be of an extraordinary nature. The following precautions were, therefore, adopted, and, as events have turned out, these have been more than justified. The spindle is of steel 18ft. long, with three bearings, one being placed on either side of the driving pulley. The diameter is 7in. in the bearings and 10in. in the part within the core. This part in the original forging was 14in. diameter, and was placed longitudinally, so as to leave four projecting ribs or radial bars, on to which the core discs are driven, each disc having four keyways corresponding to these ribs. There are about 900 of these discs, the external diameter being 20in., and the total length of the core 36in. Originally the core was provided with 32 driving teeth made of steel, each tooth riveted to sockets attached to eight of the core discs. It may here be mentioned that, as the working has shown, the strain on these driving teeth was perilously near their factor of safety; their number has been doubled, so that now the tangential strains are borne by a very considerable number of the core discs. The armature winding consists of 128 copper bars, each ¾in. deep, measured radially, by ¾in. wide. These 128 bars are coupled up so as to form 32 conductors only; this arrangement has been adopted to avoid the heating from Foucault currents, which, with 1½in. conductors would have been very considerable. The bars are coupled at the ends of the core across a certain chord according to an arrangement patented by the author and Mr. Swinburne, which consists of crescent-shaped bars so formed that the whole surface is thoroughly exposed to the current of air passing through the armature. They are also somewhat shorter than those usually employed on drum-wound armatures. The bars are insulated by a covering of fiburite, a material which has been recently introduced by Messrs. Crompton, and which will stand a temperature of 160deg. C. for long periods without the least discolouration or alteration of its mechanical or insulating properties. The commutator is 20in. long, has 64 parts, and, in addition to the usual tightening nuts at the two ends, is provided with a third tightening ring at the centre, to prevent the tendency of such long commutator strips to spring when worn down thin. The current is collected by eight brushes, mounted on a separate ring placed concentric to the commutator, and the current is led away from these brushes by a large number of bands of sheet-copper strapped together into convenient groups. The field-magnets are of the horizontal double type, and were adopted by the author and Mr. Swinburne, after a careful series of experiments which convinced them that the fashionable single-magnet form was very unsuitable for this kind of machine. As this machine is virtually a series-wound machine, the magnet-coils each consist of a few turns only of forged-copper bars, 1½in. wide by 1in. thick, forged to fit the magnet-cores. There is no insulation other than thin mica wedges to keep the bars from touching the core. The armature is ventilated by a current of air from a Shieles fan, driven by a belt from the armature spindle. At 380 revolutions the armature can give 5,000 amperes at 60 volts, and the temperature of the hottest part, which is the end-plates next the commutator, never rises beyond 70deg. C. Although this machine was designed to give only 5,000 amperes, yet, electrically speaking it is capable of doing very much more, and in actual practice it has frequently to stand a current of 8,000 amperes for short periods; but, as will be shown later, when the furnaces are employed to produce ferro-aluminium there are frequently violent oscillations in the current which would make it unsafe to employ an average current much in excess of 5,000. In fact, as has been stated above, it has been found necessary already to increase the number of driving teeth in order to provide against the driving strains at the times of maximum current. When the machine was first tried the main circuit was unprovided with a cut-out, and there is no doubt that at this time the armature stood the test more than once of temporary currents exceeding 16,000 amperes. Since that time a safety cut-out has been provided calculated to fuse at 8,000 amperes. This—probably the largest one that has ever been designed—consists of a framework carrying twelve lead plates, and these fuse at the calculated point in a most satisfactory manner without any undue detonation or scattering of the molten lead.

Next to the cut-out comes the current indicator, which is simply a solenoid of nine turns, through which the whole current passes. The core is attached by chain-gear to the pointers, of which there are two, mounted on one spindle. One pointer and dial is placed in the engine-room, and the other in the furnace-room. The gearing of the spindle is calculated so that the range of the instrument up to 8,000 amperes extends over the entire circle of 360deg. The construction of the solenoid for this indicator is somewhat novel. It is cut out of a cylinder of cast-copper by means of a parting tool in a screw-cutting lathe.

There are two furnace-rooms, each containing six furnaces, and the conductors, after leaving the current indicator, pass right across the two rooms at a height somewhat above the attendants' heads. The current is supplied to the furnaces as follows: Each furnace-pit consists of a long trough built of fire-brick, the ends being closed by cast-iron pipes, through which carbon electrodes are arranged, so that they can be moved lengthways to and fro by the attendant in charge. It will be remembered that one of the main features of the Cowles' invention is the use of limed charcoal as a lining for their furnace. They thus obtain a highly refractory non-oxidising lining, which is also a non-conductor of electricity, as the lime prevents the particles of carbon fusing together, and thus forming a continuous conductor, which would otherwise short circuit the furnace and be consumed under the action of the current, instead of the latter performing its proper duty of maintaining the furnace contents at the required high temperature. The electrodes, each of which consists of nine carbon rods attached to a cast-iron head mounted on a copper rod passing through the above-mentioned cast-iron pipes, are each provided with flexible copper wire cable connections, having an attachment sliding along the conductors, passing overhead and somewhat behind them. When it is desired to supply the current to any one furnace, the attachments are slid into position opposite it and clamped fast to the conductors. To start the furnace, the electrodes are brought together so as to touch, and then separated until the whole of the contents of the furnace between them is an incandescent mass at the required high temperature. The working of a charge in the furnace is carried out as follows: The bottom of the empty furnace is covered with limed charcoal, the electrodes are brought into position, and a former or iron box, without top or bottom, and of a size determined by the space to be occupied by the charge is placed in the furnace; the ends of this sheet-iron box are arched out so that it can be dropped over the electrodes. The furnace lining of limed charcoal is then rammed up in the space between the iron former and the furnace balls. The space inside the box is filled with the furnace charge, which, when ferro-aluminium is to be produced, consists of a mixture of charcoal, bauxite, and iron turnings, but when the cupro-aluminium is required, granulated copper is substituted for the iron turnings. When the furnace lining and contents are brought up to the proper level, the iron former is carefully lifted, much as a moulder draws a pattern from the sand. The cover is then lifted on to the furnace, and it is then ready for the electric current. This at first is kept down to 3,000 amperes, but as soon as the charge is thoroughly burned

* Paper read before the British Association at Bath.

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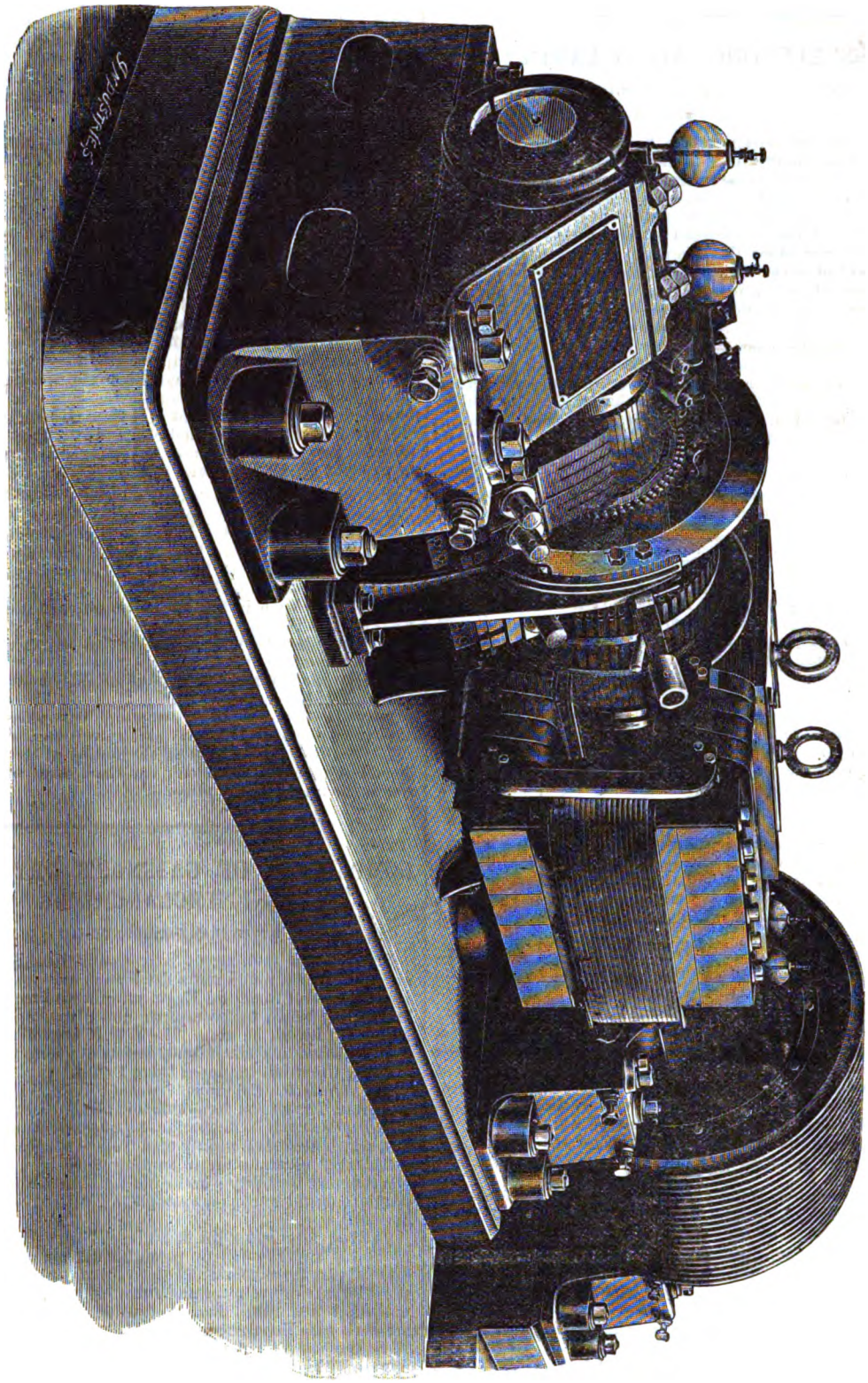
through, and the furnace contents become incandescent throughout, the current is increased to 5,000 amperes, and in about one hour the reduction is complete. The reduced aluminium trickles through the furnace contents and collects at the bottom below the electrodes, from which in the furnaces last constructed it can be tapped out continuously. Mr. Cowles believes that the temperature of the centre of the furnace is so high that both the reduced aluminium and the metal with which it is to be alloyed are vaporised and combine as a chemical compound when in this condition, being condensed in the upper and cooler part of the furnace, and from thence passing down the sides to the bottom. The working of the furnace when cupro-aluminium is to be provided leaves nothing to be desired. The current can be steadily increased. Towards the commencement and towards the end of the reduction the current is extremely constant, so that the load on the boilers, engines, and dynamos is fairly steady throughout, but when making ferro-aluminium, the conductivity of the furnace contents varies through very wide limits, and this brings heavy strains both on to the steam-engine and dynamo, which must be met by correspondingly increased strength of parts. The chief feature of the process, which strikes a visitor to Milton works, is the small number of men necessary to work the process. Two men in the engine and dynamo room, one man at the boilers, and one boy to manipulate the electrodes of the furnaces, are all that are required for the active part of the operation. Two labourers can easily charge and relime the furnaces, and the remaining staff required for melting down, standardising, and casting into ingots the various classes of furnace products, is correspondingly small. From the experience already gained, the author has no difficulty in designing and constructing engines and dynamos to supply currents of 15,000 or even 20,000 amperes, if such be required for Cowles' furnaces of enlarged size. The electrical difficulties met with in the construction of this large machine have been comparatively small, whereas the mechanical strains have been unexpectedly great, and must be provided for by extreme solidity and massive construction. Recent investigations made in America by Mr. W. J. Keep have shown that the use of ferro-aluminium is likely to be enormously extended when its properties in relation to cast iron are thoroughly understood and appreciated by the engineering world. Mr. Keep is a gentleman who is well known in America, and his statements are entitled to be received with the utmost respect. We already knew in this country that the addition of ferro-aluminium to cast steel or to ingot iron in such proportion that the finished castings will contain not more than one-thousandth part of aluminium produced extraordinary effects, in some cases reducing the melting point 300deg. C., and in all cases imparting great fluidity to the metal, thus giving us sharp castings free from blow-holes, but it has remained for Mr. Keep to show us that the addition of an infinitesimally small percentage of aluminium to cast



CROMPTON'S LARGE DYNAMO.

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iron insures perfect castings, freedom from blow-holes, and almost all the ills to which the iron founder is subject. Mr. Keep's report is so very full that it is impossible to give any *resumé* of it here. I only call attention to it, and show the extreme importance that ferro-aluminium is likely to assume in future engineering, and that, as far as we know at present, the perfected Cowles' furnace is capable of producing the desired material in any quantity at a moderate cost.

[This question was discussed last week in our contemporary *Industries*, to which we are indebted for the illustration of the dynamo used, as no illustration accompanied the paper.—ED. *E.E.*]

MINERS' ELECTRIC SAFETY LAMPS.*

BY NICHOLAS WATTS, ASSOC.MEM.INST.C.E.

(Fellow of the Institute of Patent Agents, Bristol.)

It is not necessary, the writer thinks, to devote time to inquiry into the reasons which have caused so much attention to be given to the subject of this paper by those interested in coal mining. It will suffice to say that the modifications made from time to time by numerous inventors, by providing additional gauzes and shields, and in other ways to adapt lamps constructed on the principle of the Davy, Clanny, Stephenson, and other like lamps, to the increased velocity (20ft. to 35ft. per second) of the ventilating currents now obtaining in our collieries, have resulted only in rendering such lamps less unsafe than they were, but have failed to make them free from danger, and have in some cases introduced considerable complication and other objectionable features. There being, therefore, apparently not much prospect that a thoroughly satisfactory and safe lamp of the aforesaid types would be forthcoming, it was most natural that the incandescence electric lamp should be seized upon as a probable solution of the difficulty. It appears, on the face of it, most suitable for the purpose, inasmuch as the light depends for its existence on the absence of air, a condition the direct reverse of that necessary to the maintenance of the flame in oil-lamps. The white-hot carbon filament is wholly enclosed in an air-tight glass bulb, from which all the air is withdrawn before the bulb is sealed. No currents of air or explosive mixture can reach it.

Attention having once been directed to the production of electric lamps for miners' use, the field speedily became well tenanted with inventors.

The writer does not propose to refer in detail to the successive developments, but rather to present to the meeting the position as it now is by passing in review some of the best lamps obtainable.

It became clear early in the history of the matter that illumination of collieries by fixed lamps connected to mains was not practicable so far as the working places were concerned. The difficulty of preventing injury to or severance of the wires, combined with other objections, left no doubt on that head. For like or analogous reasons, portable lamps, connected by leads to mains, were not satisfactory. Consequently, all energies were concentrated upon the production of an independent lamp containing its own source of light, and which could be carried about by the miner as freely as a Davy or other like lamp.

How to produce such a lamp, to compare favourably with a miner's ordinary oil-lamp in price, weight, illuminating power, capability of standing rough treatment and hard knocks, and in other respects, became the problem. A good lamp of the Clanny and like types is bought for about 8s., it weighs about 4lb., and gives a light of from 0·4 to 0·5 of a standard candle.

To Mr. Swan belongs the credit of being the first to p.oduce an electric safety lamp with an incandescent lamp as the novel feature thereof. This he did in 1881.

The Swan Lamp (exhibited).—Secondary battery. The elements, lead and lead-oxide, are cylindrical, and are arranged concentrically in each cell. They are contained in a block of gutta-percha, with four cell compartments enclosed in a wooden case. The exciting liquid is dilute sulphuric acid. The cells are recharged by placing the lamp on a stand connected to a dynamo. The lamp proper is attached to the side of the case, and is protected by a "bull's-eye" of thick glass. A light of from one to 1½ c.p. is given for a period of ten hours. The weight is 7lb., and the price 27s. The cost of maintenance is 3½d. per week.

Several hundreds of these lamps are now in use at Risca and elsewhere, and the writer is informed by Mr. Wilkinson, manager at Risca, that they give satisfaction.

The Walker Lamp.—Primary battery. Bichromate-carbon-zinc battery, the carbon being itself the containing vessel. On one side is a strong lens faced by a parabolic reflector, the two being held by a strong brass cylinder attached to the outer case, which is also of brass or copper. The lamp is made in two sizes, of which the smaller weighs 5lb. The battery is composed of two carbon-zinc cells. The liquid used is a mixture of bichromate of potash, nitric acid, and plain sulphuric acid. The E.M.F. is 4 volts, and the current 0·3 of an ampere. The price is—for single lamps, 30s.; for dozens, 27s.; and for grosses, 25s. The light afforded by the small lamp is sufficient to enable ordinary newspaper print to be read at a distance of 6ft. from the lamp for 10 hours. The battery of the larger lamp, which weighs 7lb., has three carbon-zinc cells. The E.M.F. is six volts, and the current 0·5 of an ampere. Price, 48s., 35s., and 32s. respectively. The cost of renewing the chemicals used, the incandescence lamp and incidental repairs, is stated to be not more than ¾d. per day for the small and 1d. per day for the large lamp. The cost of the liquid has been frequently tested, and has come out at ½d. per day of twelve hours' run. The operation of renewing, which is effected in a few minutes, consists in running off the liquid and washing out the cells, running in fresh liquid, and replacing the cover, by which last act the connections between the battery and the lamp are made.

The Pitkin Lamp (exhibited).—Secondary battery of four cells (seen last year in use underground at Tyldesley Colliery by some of the British Association). The weight of this lamp is 8lb., and the price £2. 2s. Illuminating power, four to five candles; a reflector is employed to concentrate the light. The battery is composed of four cells, each having eight plates or fingers, the elements being peroxide of lead and spongy lead. The battery takes eight hours to charge. Mr. Pitkin estimates the life of the battery at about two years. E.M.F., eight volts; current, 0·4 of an ampere. The Pitkin lamp is furnished with a switch, and a resistance to regulate the expenditure of the E.M.F., which, if allowed to act without check would, when the battery was started, destroy the filament. Mr. W. W. Hood, Llwynypia, tried fifty Pitkin lamps, and found that the switch was a difficulty. The men, unless very careful, put on the switch too full, and broke the filament.

The Schanschieff Lamp (exhibited).—Primary battery. The exciting liquid employed is a solution of basic sulphate of mercury in the acid sulphate, one part of the salt being entirely dissolved in three parts of water (according to Schanschieff's patent). The battery can be charged The battery can be charged in fifteen seconds. The elements are zinc and carbon; a single liquid only is employed, and no porous cells, producing resistance and causing waste of energy, are required. The weight, with a battery of four cells, is 4½lb. Each cell takes five fluid ounces of the mercurial solution. The light ranges from 1½ to 2 c.p. The consumption of zinc is ½lb. per shift, or ¼lb. for 48 hours (six shifts of eight hours). The liquid is supplied at 5s. a gallon, and is said to be worth, when spent, 4s. 3d., in consequence of the solid residue and free mercury precipitated by the action of the cells. The working cost of the 4-cell lamps for six shifts of eight hours is 5d., or ¼d. for one shift. In some forms of the lamp the solution occupies a little less than half the height of each cell, and the elements occupy the other half or opposite end of the cells. Thus the lamp is capable of being put out of action by inverting it. The liquid is changed every eight hours. The price is 30s.

The New Portable Electric Lamp and Power Syndicate Company's Lamp (exhibited).—The battery is secondary, and consists of two cells, the elements being lithanode (peroxide of lead) and spongy lead. The weight of the lamp is 4½lb. The light given is one candle over a period of 10 to 12 hours. The battery takes five hours to charge, the cost of recharging being 3d. per week. The price is £1. 1s. The lamp is fitted with an automatic arrangement in connection with the incandescent lamp, whereby, if the outer casing of toughened glass be broken, the current is cut off, and explosion of five-damp guarded against.

The question, Which is the most suitable battery for miners' lamps? though keenly debated, has not yet been finally settled. The secondary battery is, doubtless, more durable, but where dynamos are not already employed the primary battery will find favour.

The position of the light on the top, or at the side of the case, has given rise to much discussion; but the balance of opinion is that the side is the most suitable place.

* Paper read before the British Association at Bath.

COMPARISON OF GASSNER'S DRY CELLS WITH LECLANCHE'S.*

BY W. LANT-CARPENTER, B.A., B.SC.

Shortly after their recent introduction into England, two of Gassner's dry cells, a round and a flat form, were brought to the Hanover-square School of Electrical Engineering, with a request that they should be carefully tested and compared under varying conditions with the No. 2 size Leclanché cell. The E.M.F.'s were taken by Law's condenser method, and the internal resistances were measured by Kempe's method, the shunt employed being 1 ohm.

The results for the round Gassner cell were 1·317 volts, and 0·205 ohm, and for the flat form 1·52 volts and 0·7 ohm respectively. No attempt was made to determine the composition of the contents of the cell, which consisted mainly of a yellow opaque somewhat stiff jelly, remarkably constant under varying conditions of atmospheric temperature and humidity; hence the cells could be placed in any desired position, on their side, for example, a great convenience where space is limited.

The flat form and a No. 2 Leclanché were each circuited through 10 ohms, and the fall in potential difference observed at frequent intervals for three hours. The curve representing the rate and amount of fall of the dry cell was much more regular, and showed a total fall somewhat less than that of Leclanché. Both cells, after six days interval, were short circuited through 2 ohms for two minutes, and their recovery from polarisation observed at frequent intervals for 65 minutes. This caused a fall of 0·21 volts in the dry cell, and of 0·552 volts in the Leclanché; the curves of recovery showed that while the flat dry cell recovered 85 per cent. of this loss in 6½ minutes, and nearly the whole of the remainder in the succeeding 10 minutes, the Leclanché cell required 18 minutes to recover the same proportion of its loss, and 30 minutes to arrive at the same E.M.F. as the dry cell. The latter, however, did not alter appreciably afterwards, while the Leclanché continued to recover slowly for some hours.

The two dry cells, and two No. 2 Leclanché cells, were then short circuited through 1 ohm for one minute, and frequent throws of the galvanometer were taken, to determine the respective rates of recovery of polarisation. The results were very similar, both dry cells recovered the greater part of their lost E.M.F. in seven minutes, and the sub-

* Paper read before the British Association at Bath.

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sequent recovery was very slow, while the two Leclanché's required at least double the time to recover in the same proportion.

The resistance of a ringing bell, determined by the reproducod deflection method, was ascertained to be 20 ohms. The same four cells were then circuited through 20 ohms for 168 hours each, and observations of their potential differences were made, with the annexed results

Four cells circulated through 20 ohms potential difference at terminals in volts.

Time.	Leclanché No. 1.	Leclanché No. 2.	Dry cell, round.	Dry cell, flat.
hrs. mins.	volts.	volts.	volts.	volts.
— 10	1·06	1·16	1·21	1·06
— 15	·988	·999	1·20	1·03
— 20	·938	·933	1·19	1·015
— 30	·905	·883	1·17	·977
— 35	·900	·844	1·17	·949
1 50	·778	·679	1·10	·778
3 45	·651	·646	1·04	·712
22 5	·508	·392	·833	·518
27 40	·480	·370	·828	·508
*48 10	·430	·342	·778	·447
51 40	·419	·337	·767	·436
72 0	·414	·326	·728	·364
96 10	·386	·326	·695	·298
168 0	·320	·309	·618	·171
E.M.F.'s at starting :	1·41	1·435	1·31	1·35
Internal resistances at	ohms.	ohms.	ohms.	ohms.
starting	·741	·635	·252	·618
*Ditto at				
48 10	·69	·59	·205	·455

The following table shows the manner of recovery of the same four cells :

E.M.F.'s of the same four cells when recovering from the polarisation due to being circuited through 20 ω for 168 hours. (Time reckoned from the instant of breaking the circuits.)

Time.	Leclanché No. 1.	Leclanché No. 2.	Dry cell, round.	Dry cell, flat.
hrs. mins.	volts.	volts.	volts.	volts.
— 30	·502	·524	·646	·237
— 40	·524	·556	·662	·243
1 50	·662	·750	·723	·309
2 40	·728	·827	·729	·346
24 50	1·13	1·13	·956	·690
25 58	1·13	1·14	·968	·701
26 40	1·14	1·15	·973	·706
29 5	1·15	1·16	·984	·717
48 10	1·19	1·20	1·04	·778
50 40	1·20	1·21	1·04	·789
53 40	1·20	1·22	1·06	·795
71 50	1·24	1·30	1·10	·828
77 50	1·25	1·31	1·11	·840
96 25	1·29	1·35	1·15	·867
168 10	1·36	1·40	1·21	·934
192 10	1·37	1·40	1·23	·956
360 0	1·39	1·42	1·27	1·05

After this, the following results were obtained :

Internal resistance of dry cell (round) = ·26 ω } by Mance's bridge
" " " (flat) = ·63 ω } method.

The round dry cell and No. 2 Leclanché were each circuited through 3 ohms.

Time.	No. 2 Leclanché. Current amperes.	E M F volts.	P.D. volts.	Intnal. restnce ohms.	Dry Cell (round). Current amperes.	E. M. F	P.D.	Intnal restnce
hrs. mins.								
— 0	—	1·42	—	—	—	1·27	—	—
— 5	·203	—	·608	—	·270	—	·811	—
— 8	·169	·554	·507	·277	·257	·811	·772	·151
— 11	·149	·546	·447	·442	·255	·803	·764	·153
— 16	·146	·499	·437	·429	·247	·780	·741	·157
— 19	·174	·484	·421	·444	·239	·772	·717	·228
— 23	·135	·468	·405	·440	·234	·764	·702	·266
— 34	·125	·437	·374	·500	·221	·710	·663	·212
1 0	·101	·367	·304	·615	·205	·647	·616	·152
1 25	·083	·312	·249	·750	·190	·624	·569	·287
1 53	·068	·234	·203	·461	·182	·586	·546	·214
2 25	·052	·187	·156	·600	·172	·554	·515	·227
3 23	·044	·164	·152	·700	·159	·515	·476	·246
5 30	·039	·140	·117	·600	·130	·429	·390	·300

Recovery of No. 2 Leclanché and dry cell (round) after being circuited, as in the last table.

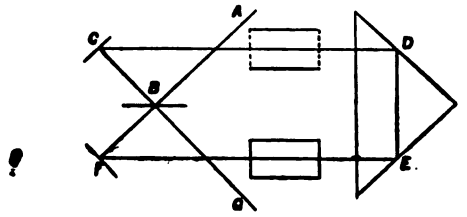
Time.	No. 2 Leclanché, E.M.F.	Dry cell (round) E.M.F.
hrs. min.		
0	·14	·429
17 53	1·09	1·05
17 58	1·09	1·07
20 43	1·10	1·07
22 43	1·12	1·09
90 8	1·30	1·23
114 0	1·33	1·24
117 0	1·34	1·25

It appears from all these results that the round form of Gassner's dry cell polarises less than a No. 2 Leclanché, and is also of considerably lower internal resistance (the average value being 0·25 ohm); further, that although the dry cell takes somewhat longer to completely recover its E.M.F. when the circuit is opened, the rate of recovery is more rapid than that of the Leclanché for the first five or ten minutes. The flat form of dry cell appears to behave in most cases not quite so well as a No. 2 Leclanché, the internal resistance being about the same—viz., 0·6 ohm. I should add, in conclusion, that the measurements here described were made under the superintendence of Mr. E. C. Rimington.

IS THE VELOCITY OF LIGHT IN AN ELECTROLYTIC LIQUID INFLUENCED BY AN ELECTRIC CURRENT IN THE DIRECTION OF PROPAGATION.*

BY LORD RAYLEIGH.

The question here proposed has been considered by Roite (Pogg. Ann. 150, p. 164, 1873), and by Lecher (Rep. de Phys. 70, p. 151, 1884).† My experiments were made in ignorance of the work of these observers, and the results would scarcely be worth recording were it not that the examination seems to have been pushed further than hitherto. It may be well to say at once that the result is negative. The interference fringes were produced by the method of Michelson, as used in his important investigation respecting "The influence of motion of the medium upon the velocity of light."‡ The incident ray, *a b*, meets a half-silvered



surface at *b*, by which part of the light is reflected and part is transmitted. The reflected ray follows the course, *a, b, c, d, e, f, b, g*, being in all twice reflected at *b*. The transmitted ray takes the course, *a, b, f, e, d, c, b, g*, being twice transmitted at *b*. These rays, having pursued identical paths, are in a condition to form the centre of a system of fringes, however long and far apart may be the courses, *c, d, e, f*. There is here nothing to distinguish the ray, *a, b*, from a neighbouring parallel ray. The incident plane *wave front* perpendicular to *a, b* gives rise eventually to two coincident wave fronts perpendicular to *b, g*. With a wave incident in another direction the case is different. The two emergent wave fronts remain indeed necessarily parallel, both having experienced an equal number of reflections (4 and 6). But there will exist in general a relative retardation of amount (for wave fronts perpendicular to the plane of the diagram) proportional to the deviation from the principal wave front. Hence, if the incident light comes in all direction, a telescope at *g*, focussed for infinitely distant objects, reveals a system of influence bands whose direction should be vertical, if the adjustments could be perfectly carried out in the manner intended.

The success of the method does not require the complete symmetry of the diagrams. If the reflections at *d, e* are effected by a right-angled prism, it is necessary that *c, d, f, e*, be parallel to one another, but not that they be parallel to the surface, *b*. Supposing all the surfaces to remain vertical in any case, the positions of *b, f*, and the incident ray, *a, b*, may be chosen arbitrarily. If the distance, *d, e*, between the parallel courses is not closely prescribed, *one* adjustment by rotation of the mirror, *c*, will suffice. In my experiments the optical parts were mounted upon a large iron plate, so that the movable pieces, *c, d, e*, could be shifted without loss of level. The incident ray, *a, b*, was defined by a small hole near the paraffin-lamp which served as a source of light, and by the centre of moderately large circular aperture perforated in a screen and illuminated when necessary with a candle. The mirror, *c*, was then rotated, until the rays, *c, d, f, e*, were parallel. This was tested by observing the equality of their mutual distances near the extremities of their course.

* Paper read before the British Association at Bath.

† Mr. Wilberforce has experimented upon displacement currents in a dielectric (Camb. Phil. *Trans.*, t. xiv., p. 170, 1887).

‡ *American Journal*, xxxi., p. 377, 1886.

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If the distance between the parallel rays is prescribed, the adjustment is more troublesome. The line, *f e*, being fixed, sights are laid down defining the desired position of *c d*. These sights, as well as those before referred to defining the incident ray, have now to be brought to apparent superposition as seen by an eye looking along *d c*. For this purpose *two* conditions have to be satisfied by, and two motions must be provided for, the mirror, *c*. One of these should be a movement of rotation, and the other of translation in a direction nearly perpendicular to the plane of the mirror. Thus the mounting may consist of a circular turntable resting upon the iron plate, the curved edge of which is guided by a V cut out of a flat piece of metal and clamped to the plate. In each position of the V the angular motions are easily swept over, and the double adjustment is effected without much difficulty. When the parallelism of the rays is secured, the insertion of the reflecting prism is all that remains. The adjustment of this is best effected with the eye at the observing telescope, which at this stage should be focussed upon the small aperture in the neighbourhood of the flame. By a motion of the prism parallel to its hypothenuse the two images are brought to coincidence,* and then the bands appear, if not at once, when the telescope is accommodated for infinitely distant objects.

The half-silvered central plate would be at its best if it reflected light of the same intensity as it transmits. I have generally found the reflection on the side next the air more powerful than upon the side next the glass, so that the ideal would require the geometric mean of the two reflections to be equal to that of the two transmissions. A very slight silvering is all that is wanted, such as from its want of coherence and brilliancy would be useless for other purposes; and the bands appear tolerably black, even though the interfering lights are of decidedly unequal intensities. There is, of course, also a reflection from the unsilvered surface of the plate. In my apparatus, owing to a want of parallelism, this image was distinctly separated from the other. The two back reflectors were of flat glass, silvered by the milk-sugar process, and used as specular.

The imperfections of the surfaces disturbed the formation of the bands from full accordance with theory. The definition was usually better when the pencils were limited, as by the screens employed to define the incident ray than when all destructions were removed. The final adjustments for the distinctness and desired width of bands were made with the eye at the telescope by shifting the reflecting prism, and occasionally by slight displacements of one of the other reflectors. The tubes enclosing parts of *c d*, *f e*, and containing the electrolyte (diluted sulphuric acid of nearly maximum conductivity) were closed at the ends by plates of parallel glass. The current entered by lateral attachments, so arranged that liquid (or gas) rising or falling from the platinum electrodes would not at first enter the operative part of the tubes. The diameter of the tubes was about ¾in., and the effective length about 11in.

It will be sufficient to give the details of one experiment. The two tubes were connected in multiple arc, and, of course, in such a manner that the current travelled in opposite directions. The magnitude of the whole current (say from eight Grove cells) was 1·5 amperes, so that the current *density* in amperes per square cm. was

$$\frac{\cdot 75}{\pi \times \cdot 38^2 \times 2\cdot 54^2} = \cdot 26.$$

Now, one of the interfering rays travelled 22 inches, or 56 centimetres, with the current, and the other ray the same distance against the current. On *reversal* of the current no shift of the bands could be perceived, under conditions where a shift of $\frac{1}{10}$th† of a band must have been evident. Hence, we may conclude that a current of the above-mentioned density does not accelerate, or retard, the propagation of light in the ratio of $\frac{1}{10}$th λ to 224 cms. In the liquid we may take $\lambda = 4 \times 10^{-5}$ cm.; and if we reduce the result so as to correspond to density unity, we may say that in dilute sulphuric acid a current of one ampere per square cm. does not alter the velocity of light by one part in 13 millions, or by 15 metres per second.

It would probably be possible to carry the test 10 or 15 times further by the use of much longer tubes and a more powerful battery; but there seems to be no sufficient encouragement at present to make the attempt. The case would, of course, be very different were anyone to show by *a priori* argument a reason for expecting an effect of this order of magnitude.

VORTEX ANALOGUE OF STATIC ELECTRICITY.‡

BY PROF. W. M. HICKS, F.R.S.

Consider two bodies touching one another placed in an infinite fluid, and with a vortex filament, the ends of which are one on one surface, the other on the other. If now the surfaces be separated from one another, there will be formed, at the point where they separate, a hollow vortex filament stretching from one to the other, with rotation equal and opposite to that of the original filament. As the bodies are moved apart these filaments will not, in general, take up a position of rest. If the strength of the original filament be very great, or if there be several of them, the resulting hollow vortex will, through instability, split up into a number of smaller ones. If the resulting number be very large, they will ultimately take up some position of stable equilibrium. What the distribution in this will be, I cannot say, but the following is one state of equilibrium, and, probably, although I have not proved it, a stable one. The two sets of filaments will be mixed up with one another, and each will distribute itself according to the same law as the distribution of lines of force between the two bodies supposed equally and oppositely electrified.

In the case of the original filament, as the surfaces are further and further separated, their sections become smaller and smaller. This is, however, not the case with the hollow filaments. Their section depends only on the pressure of the fluid and their circulation, and, as these remain constant, the areas of their section also remain so. In such a hollow vortex the pressure inside sinks to zero. Consequently the portion of the surface on which it abuts experiences a diminution of pressure, a diminution which is the same at all distances. The two bodies are therefore attracted towards one another. Moreover, as the two bodies separate further, the distribution of the filaments being the same as that of electrical lines of force, and the diminution of pressure for each line being constant, it follows that the force between the two bodies follows precisely the same laws as the force between the two bodies supposed equally and oppositely electrified.

If another surface be brought into the presence of the others, some of the filaments would abut on this. These would break off, rearrange themselves so that some of the filaments would end on it, and an equal number start from it. Call those ends of the filaments positive at which the rotation, looked at *from* the surface on which they abut, is right handed; and those ends negative at which the rotation is left handed. The two ends of any filament will then always be of opposite name.

The analogy with electrical action is then close. Two bodies, A B, brought in contact touch in innumerable points. Owing, possibly, to the different states of motion of the ether at their surfaces, a state of equilibrium is set up, consisting of a kind of sifting of vortex motion already subsisting, so that, on the whole, more lines go from A to B than *vice versa*. This is E.M.F. of contact. Separate the bodies, one has a number of positive ends of hollow filaments, and the other an equal number of negative ends. *The bodies are equally and oppositely electrified.* The force, in its hydro-dynamical case and in its electrical analogue, follow the same laws. Bring into the field another surface, C. The filaments rearrange themselves as mentioned above, the negative and positive ends abutting on C being equal. *This is induced electricity.* If the surface C consists of a large number of small unconnected surfaces, the filaments will arrange themselves in some manner depending on the sizes and distances of the unconnected parts, the field will be disturbed in a similar way to that in an electric field into which a different dielectric is placed. This is the analogue of electric strain in a dielectric. So far, the ground is fully safe; the succeeding remarks must be regarded as speculative.

Returning to the case of the two separated surfaces, A and B, what will happen if they be connected by a third surface—say, to fix ideas, a long narrow cylinder or wire? It is not so easy to say certainly what the exact rearrangement will be. It would seem very probable that the hollow filaments near the wire would at once be replaced by circulation round the wire. In this case the solid filaments must rotate as a whole round it, while, at the same time, although this has not been proved, they will contract their ends, move along until they come together, form a ring, and get mixed up in the surrounding fluid. This would correspond to the *current of discharge*. But notice that if this is so, the fluid outside the wire rotates round the wire while a stationary state is being reached, and as we know that the field round a current is a magnetic field, it follows that the *analogue of a magnetic field is a flow along the magnetic lines of force*. It may, however, be further necessary that these streams must contain vortex filaments moving with the fluid, their axes at every point being perpendicular to the lines of force there.

If the field is determined by the flow of fluid independently of the vortex motion, it is not easy to see the hydro-dynamical analogue of the induction of currents, when, say, a wire moves across a uniform magnetic field. If, however, the vortex filaments, as above, are a necessary adjunct, it is conceivable how a movement of the wire across the lines of flow and amongst the filaments produces an instantaneous disarrangement, which will travel through the vortical fluid with the velocity of propagation of transverse vibrations in a vortical fluid. That is in the ether, as Sir W. Thomson has shown, with the velocity of light.

It is difficult to see any analogue to the rotation of the plane of polarisation of light by a magnetic field.

ON AN APPARATUS FOR DETERMINING TEMPERATURE BY THE VARIATION OF ELECTRICAL RESISTANCE.*

By Wm. Shaw, M.A., Lecturer on Physics in the University of Cambridge.

This apparatus is designed to measure to a high degree of accuracy the mean temperature of a large burette immersed in a water bath. A Wheatstone quadrilateral is formed by joining the ends of a platinum wire about 30in. long (resistance about 11 ohms) to those of a platinum silver wire, B, C, D, A. The platinum wire is base, and the alloy is silk-covered ·007in. in diameter. Its resistance is 13·5 ohms per metre. At A C and B D respectively, battery and galvanometer wires are soldered. The lengths of the wires are so arranged that for some temperature near 15deg.C. there is a perfect balance indicated in the bridge. The wires are laid in parallel lengths, and disposed upon a strip of pure indiarubber about ¾in. wide in the manner indicated in

* It should be noticed that if the object were at infinity, or if with the aid of a collimating lens an image of it were thrown to infinity, the two images as seen focussed through the telescope would overlap in any case. For it may be proved that whatever may be the positions of the fine reflecting surfaces, the two emergent rays, corresponding to any incident ray, are necessarily parallel.

† Probably I might say $\frac{1}{20}$th, but it is best to be upon the safe side. When the contact was maintained a slight shift was observed, but in a direction independent of that of the current.

‡ Paper read before the British Association at Bath.

* Paper read before the British Association at Bath.

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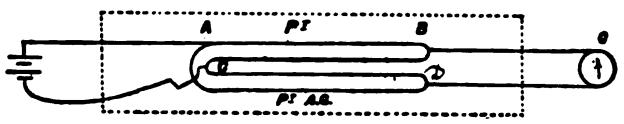
the figure. The indiarubber is painted with a solution of indiarubber in benzene, and a second strip, similarly painted, is laid down upon it, and the wires are thus completely enclosed; the strip continues 18 metres at each end beyond the junctions of leading wires, so that the whole length of strip is about 5½ft., and from the two ends the galvanometer and battery leads respectively project.

A very flexible quadrilateral is thus obtained in the form of a ribbon, which can be wrapped round any apparatus whose temperature is required. Since the two wires, which together form the quadrilateral, have different temperature co-efficients, there is no balance except for one particular temperature, but the balance can be restored by shunting either the wire, A B, or the arm, B C, by connecting a resistance-box in a suitable manner with the projecting leads. The



resistance of the shunt required to produce a balance can be employed to indicate the temperature when the instrument has once been graduated. The graduation of the apparatus exhibited was made for the author at the Cavendish Laboratory by Mr. J. W. Capstick, demonstrator at University College, Dundee. The ribbon was wound round a metal cylinder, and the whole immersed in ice or water, and a number of readings of the shunt taken at different temperatures between 0deg. and 28deg.C. The conductivity of the shunt at different temperatures is very nearly represented by a straight line cutting the zero line at the neutral point, 15-16deg.C. The maximum divergence from the straight line corresponds to the temperature difference of a fifth of a degree between 0deg. and 151-6deg., and to about a tenth of a degree between 15-16deg. and 28deg. In the graduation the temperatures are referred to the Kew standard by means of mercury thermometers previously compared at Kew. The temperature can be read with a suitable galvanometer to about the 500th of a degree.

THE PROTECTION OF ELECTRIC LIGHT STATIONS FROM LIGHTNING.*

BY W. J. JENKS.

(*Concluded from page 208.*)

The most desirable method in an electric light station, or, in fact, in connection with any building to be protected, is to connect with as many good grounds as are available. From the centre of distribution, or lightning arrester, a ribbon of copper or galvanised iron, say, $\frac{1}{16}$ inch thick and an inch wide, should take as straight a route as possible to the points of contact with pipes or ground plates. Smaller copper tapes may lead from the main ribbon to each of the connections, and, after making the contacts bright, they should be carefully soldered, and the whole may then be covered with tape or other convenient insulation. It is always better in stations or dwellings to insulate these ground wires on porcelain or other non-combustible material, so that in case of corrosion or any accident, the setting up of an arc between the disjointed ends shall not fuse wood or other combustible substances near them.

In the case of rods, however, on the outside of buildings, insulation is generally not only unnecessary but foolish and possibly dangerous. With few exceptions, all metallic surfaces or masses employed in the construction of buildings should be carefully connected with the rod itself; one very important object is thus to attain the keeping of all the metal surfaces of the building at the same potential as the earth, and thus giving the lightning flash a large capacity for conduction to ground.

The exceptions to connecting iron about buildings with the rods which protect them have been noted by eminent authorities as balconies or other masses of metal upon which people may stand at the time of electrical discharges, and thus form terminals to receive the flash on its way to earth.

An occasional test of the earth connections is one of the important things to the central station manager. The most carefully-made grounds may become disconnected by corrosion or mechanical injury of the conductors. Siemens has suggested a valuable method, which, though somewhat complex, can be readily mastered and applied in a practical form. A simple way is to so arrange the rigid ground wires as that a galvanometer and Leclanché cell can be readily connected with two independent grounds, and by a deflection, when the conductors are so coupled as to complete the circuit through the earth, show at any time whether any change in their resistance has taken place.

The form of arrester most suitable for the protection of central station apparatus has for the past six months been the subject of much careful thought. The peculiar experience of many central stations, and particularly of those which have adopted the municipal system, seemed at first only to add complexity to the problem. The extraordinary precautions taken in insulating this system of widely radiating lines have demonstrated in the first place that these lines covering sometimes several square miles of territory, serve as a gathering ground for charges which often concentrate at the dynamo or act as connecting links through the dynamo between the widely separated clouds. In some cases where armatures have thus been destroyed, it seems to be impossible to account for the peculiar features on any theory except that there was no special tendency to jump to earth, but that the current used the dynamo only as a connecting link between the widely separated points brought near together by lines of wire diverging from the central station.

Feeling that this was one of the questions upon which the most exhaustive study should be extended, the matter was some months ago referred to Mr. Edison, and, upon thinking it over carefully, seemed to him clearly analogous to his experience in the case of the protection of the phonoplex telegraph system from lightning. This has always been found a difficult matter, in the same way that the protection of the system of alternating-current transformers has thus far proved an unsolved problem. The condenser which is necessary to the action of the phonoplex, with its plates of large capacity separated only by a thin insulation, seem to invite the atmospheric discharge towards the easy channel; and then, when the capacity of the condenser was filled, the arrested energy found its way in a flash through the insulation. Thus, also, large numbers of converters are on record as having been burned out by atmospheric flashes almost as fast as they could be put up. In the dynamo armature, considerable surfaces of wire, connected directly with the lines, are brought into immediate proximity with the core, the shaft, the bus frame, and sometimes with water pipes, thus inviting a flow of current to the point of weak insulation. Mr. Edison's idea is the providing of a point of still weaker insulation before the dynamo is reached.

No definite form of future central station arrester has yet been decided upon, but it is probable that the air condenser will be used, having numerous ground plates separated from those of the line by a very small air space, perhaps $\frac{1}{50}$th of an inch. In case of a discharge which might be followed by the line current, a fusible wire will be used, situated so as to melt and open the circuit before damage could be done.

The fuse can be instantly replaced even while the shower is in progress, or, if necessary, the arrester itself can be changed in a few seconds. Working models embodying this idea are soon to be sent by Mr. Edison to some of the stations which have been most afflicted for practical trial.

In addition to this central station protection applied to the bus bars as a distributing point for a general system, it is very desirable that arresters be placed at several points on the conductors of a three-wire or midway of the resistance of each circuit of a municipal system of any size. It is suggested that one three-wire arrester be placed on each section of main in some convenient and accessible building where a ground which is unquestioned can be readily secured. This special arrester will also be provided with fusible cut-outs, enclosed in a porcelain case sufficiently ventilated to prevent any breakage by explosive action, and to prevent a possible communication of any fire from an arc. With a dozen or twenty of these small arresters, which can be periodically inspected after severe showers, in addition to a central station arrester, it is pretty evident that our stations will be protected far better than heretofore, to say the least.

*Abstract of paper read before the Association of Edison Companies.

Wood-Sawing Motor.—The proprietor of a saw-mill claims that with a 6 h.p. electric motor he can do more work than with a 10 h.p. steam-engine.

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THE ELECTRICAL TRANSMISSION OF POWER.*

BY PROF. AYRTON, F.R.S.

What is power, and why should we wish to transmit it? Power has one very definite meaning in science, and several rather vague meanings in practice. We speak of a powerful athlete, the power of the law, we sing of the power of love, we say knowledge is power, and so on, using the word in several different senses. Now, in spite of the fact that a general audience feels a little anxious as to what troubles may be in store for it when a lecturer begins by being painfully exact, my telling you that by "power" an engineer understands, the rate of doing work, will not, I hope, make you fear that my remarks will bristle with technicalities.

When you walk upstairs you exert power, only, perhaps, the one-twentieth of a horse when you go up slowly talking to other people. But when you run upstairs because you have forgotten something that you intended to bring down, then your exertions represent perhaps one-tenth of a horse-power. You only get to the top of the stairs in either case, but the breathless sensation of running fast upstairs tells you that the more quickly you go the harder you are working. A person exercises power in the engineer's sense when he exerts himself physically, and the greater the exertion the greater the power. The exercise of power by the ruling classes, however, is unfortunately not necessarily accompanied by any exertion, physical or mental.

Probably the most familiar example of exerting power at a distance, that is, of transmitting power, is pulling a handle and ringing a bell in another room. I pull the handle, exerting myself slightly, and as the result the bell at the other end of the platform rings. Were not this such a very familiar operation, I would call it experiment No. 1. You have, doubtless, all of you performed this experiment several times to-day, and, what is all important with an experiment, performed it successfully.

And yet it was not until just 100 years ago that it dawned on people that if one person, A, wanted to attract the attention of another person, B, the place where the bell ought to sound was where B was, and not where A was. Indeed, in many English villages down to the present day the knocker principle of attracting attention is alone resorted to, with the result which you may remember happened when Mr. Pickwick was staying in Bath at lodgings in the Royal-crescent, and Mr. Dowler undertook to sit up for Mrs. Dowler, but "made up his mind that he would throw himself on the bed in the back room, and *think*, not sleep, of course. . . . . Just as the clock struck three there was blown into the crescent a sedan-chair, with Mrs. Dowler inside, borne by one short, fat chairman, and one long thin one. . . . . They gave a good round double knock at the street door. . . . . 'Knock again, if you please,' said Mrs. Dowler, from the chair. 'Knock two or three times, if you please.' The short man stood on the step, and gave four or five most startling double knocks of eight or ten knocks apiece, while the long man went into the road and looked up at the windows for a light. Nobody came. It was as silent and as dark as ever." But the tall thin man, you may remember, "kept on perpetually knocking double knocks of two loud knocks each like an insane postman," till Mr. Winkle, waking up from a dream "that he was at a club where the chairman was "obliged to hammer the table a good deal to preserve order," met with the catastrophe which the readers of Mr. Pickwick will remember. This episode shows what it is to have plenty of power and no means of transmitting it.

But if some houses can still dispense with mechanical or other methods of transmitting power, even to ring bells, factories cannot. The looms, the lathes, or whatever the machinery used in the factory may be, must either be worked by hand or foot, in the old style, or it must be connected with the steam, gas, or water engine in the new. On entering a large factory, you see lines of rapidly-rotating shafting, and a network of rapidly-revolving belting, all employed in transmitting power. As a contrast to this, I now throw on the screen a photograph of Sir David Salomon's workshop at Tunbridge Wells, in which every machine is worked by a separate electric motor, thus saving to a great extent the loss of power that usually accompanies the mechanical transmission.

In America there are 6,000 electro-motors working machinery, in Great Britain hardly 100.

But it is not only in transmitting the power from the steam, gas, or water engine of a factory to the various machines working in it, that electricity can be utilised. An incredible amount of power is daily running to waste in this and other countries, because many of the rapid streams of water are too far away from towns for their power to have been hitherto utilised.

The holiday tourist, when admiring the splashing water dashing over the stones, hardly realises that the money loss is as if the foam were composed of flakes of silver.

If we take as a low estimate that a large well-made steam-engine burns only two pounds of coal per horse-power per hour, the coal consumption which would be equivalent to the waste of power at Niagara would exceed 150 million of tons per annum, which, at only five or six shillings per ton, means some 40 million pounds sterling wasted. And descending from big things to small, the river Avon, flowing through Bath, which, so far from being a roaring cataract, especially in dry weather, pursues its course with only a respectable orderly swish, still represents a certain amount of lost power. It has been estimated that from 25 to 130 h.p. runs to waste at the Bathwick Weir, behind the Guildhall, depending on the season. If we take, as an all round average, that the fall of this weir represents 50 h.p., and that a steam-engine producing this power burns 150lb. of coal per hour, it follows that with steam coal at 16s. per ton, the price at Bath, the waste at Bathwick Weir represents an income of £450 per annum, not a princely fortune it is true, but too large to be utterly thrown away as at present.

This state of things will, I hope, however, be shortly remedied, for, as you will see from the large map on the wall, it is proposed to put up 81 electric arc lamps throughout the streets of Bath, and to supply the 50 h.p. required for these lamps by the fall of the Bathwick Weir, supplementing the fall with a steam-engine at dry seasons.

The next large diagram shows the use that Lord Salisbury has made of the River Lea to electrically light Hatfield House and to supply electric motive power to the various machines working on his estate. The following diagram shows the course of the Portrush electric railway, six and a-half miles long, which is worked by the Bushmill Falls, situated at about one mile from the nearest point of the railway; and lastly, this working model on the table, kindly lent me by Dr. E. Hopkinson, as well as the diagram on the wall, represent the Bessbrook and Newry electric tramway, a little over three miles in length, which is also worked entirely by water-power, the turbine and dynamo which convert the water-power into electric power being at about three-quarters of a mile from the Bessbrook terminus. (Model electric tramway shown in action.)

The newspapers of last week contained a long account of the spiral electric mountain railway that has just been opened to carry people up the Burgenstock, near Lucerne, and worked by the River Aar, three miles away, so that we see electric traction worked by distant water-power is extending. But, splendid as are these most successful uses of water-power to actuate distant electro-motors, it is but a stray stream here and there that has yet been utilised, and countless wealth is still being squandered in all the torrents all over the world.

The familiarity of the fact makes it none the less striking that, while we obtain in a laborious way from the depths of the earth the power we employ, we let run to waste every hour of our lives many, many times as much as we use.

It is also a well-established, time-honoured fact that large steam-engines can be worked much more economically than small ones, and that, therefore, if it were possible to economically transmit the power from a few very large steam-engines to a great number of small workshops there would be a great saving of power, as well as a great saving of time from the workmen in these many small workshops, having only to employ this power for various industrial purposes, instead of having to stoke, clean, repair, and generally attend to a great number of small, uneconomical steam-engines.

When delivering the lecture which I had the honour to give at the meeting of the British Association at Sheffield nine years ago I entered fully into Prof. Perry's and my own views on the subject, and, therefore, I will not enlarge on them now. You can all realise the difference between the luxury of merely getting into a train instead of having to engage post-horses, of being able to send a telegram instead of employing a special messenger, or being able to turn on a gas-tap and apply a match when you want a light instead of having to purchase oil and a wick and trim a lamp. Well, a general supply of power to workshops is to the manufacturer what a general supply of light or a general supply of post-office facilities is to the householder. It is all part of the steady advance of civilisation that leads the man of to-day to go to the tailor, the shoemaker, the baker, the butcher instead of manufacturing his own moccasins and lassoing a buffalo for dinner. And in case any of you may be inclined to think that we have gone far enough in these new-fangled notions, and we are all perhaps prone to fall into this mistake as we grow older, let me remind you that while each age regards with justifiable pride the superiority of its ways to those of its ancestors, that every age will appear but semi-civilised to its great grand-children. Let us accept as an undoubted fact that a general distribution of power would enable the wants of civilised life to be better satisfied, and therefore would greatly benefit industry.

There are four methods of transmitting power to a distance: 1. By a moving rope. 2. By air compressed or rarified at one end of a pipe operating an air motor at the other end. 3. By water forced through a pipe working a water motor. 4. By electricity.

We have an example of transmission of power through a short distance by an endless belt or rope in the machines geared together by belts on this platform, and in the rotatory hair-brushes at Mr. Hall's establishment in the Corridor, Bath. At

* Lecture delivered at the Drill Hall, Bath, on Friday, September 7th, 1888.

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Schaffhausen, and elsewhere in Switzerland, the principle is employed on a large scale. Spain and other countries use it in connection with the mining operations, and, lastly, wire ropes replace horses on many hilly tramways.

For short distances of a mile or so there is no system of transmitting power in a *straight line* along the open country so cheap to erect, and so economical of power as a *rapidly* moving endless rope; but the other systems give much greater facilities for distributing the power along the line of route, are much less noisy, and far surpass wire-rope transmission in economy when the rope must move somewhat slowly, as in tramway traction, or when the distance is considerable over which the power is transmitted, or when the line of route has many bends.

In the same sense that an ordinary house bell may be considered as a crude example of the transmission of power by a moving rope, the pneumatic bell at the other end of the hall which I now ring by sending a puff of air through the tube is a crude example of the transmission of power by compressed air (pneumatic bell rung). Compressed air is employed to work from a distance the boring machines used in tunnelling; the continuous vacuum brakes used on many of the railways are also probably familiar to you, and the pneumatic system of transmitting power to workshops is shortly to be tried on a fairly large scale at Birmingham.

But distribution of power by water pressure is the plan that has hitherto found most favour in this country. That little water motor at the other end of the platform rapidly revolves when I work this garden syringe, and serves as a puny illustration of the transmission of water pressure (experiment shown). Pressure water has been employed for years on a large scale at Hull for distributing power; also by Mr. Tweddle as a means of communicating a very large amount of power through a flexible tube to tools that have to be moved about, but the grandest illustration of this principle is the vast system of high pressure mains that has been laid throughout London, as you will see from the photograph that I now project on the screen of the map, kindly lent me by Mr. Ellington.

The economy of this system is so marked, and the success that has attended its use so great, that, did I not feel sure that electricity offers a grander system still, it would be with fear and trembling that I should approach the subject of this evening, the "Electric Transmission of Power." *Punch* drew, six years ago, the giant steam and the giant coal looking aghast at the sucking-babe electricity in its cradle. That babe is a strong boy now; let the giant water look to its laurels ere that boy becomes a man. For the electric transmission of power, even now, bids fair to surpass all other methods in (1) economy in consumption of fuel; (2) more perfect control over each individual machine—for see how easily I can start this electric motor, and how easily I can vary its speed (experiment shown); (3) ability to bring the tool to the work, instead of the work to the tool—this rapidly rotating polishing-brush with its thin, flexible wires, conveying the power I can handle as easily as if it were a simple nail-brush; (4) in greater cleanliness—no small benefit in this dirty, smoky age; (5) and lastly, there is still one more advantage possessed by this electric method of transmitting power that no other method can lay claim to—the power which during the daytime may be mainly used for driving machinery, can, in the easiest possible way, be used during the night for giving light. I turn this handle one way, and the electric current, coming by one of these wires and returning by the other, works this electro-motor; now I turn the handle the other way, and the current, which comes and returns by the same wires as before, keeps this electric lamp glowing (experiment shown).

It might be said that the transmission of power by coal gas, which I have excluded from my list, fulfils the condition, but so also does the transmission of power by a loaded coal waggon. In both these cases, however, it is the fuel itself that is transmitted, and not the power obtained by burning the fuel at a distant place.

Let us study this electric transmission a little in detail. I pull this handle, and the bell at the other end of the room rings; but in this case there is no visible motion of anything between the handle and the bell. (Electric bell rung by an electric current produced by pulling the handle of a very small magneto-electric machine.) Whether I ring the bell by pulling a wire, or by sending an air puff, or by generating an electric current by the exertion of my hand, the work necessary for ringing the bell is done by my hand, exactly as if I took up a hand-bell and rang it. In each of the three cases I put in the power at one end of the arrangement, and it produces its effect at the other. In the electric transmission how does this power travel? Well, we do not know. It may go through the wires, or through the space outside them. But although we are really quite in the dark as to the mechanism by means of which the electric power is transmitted, one thing we do know from experience, and that is this: given any arrangement of familiar electrical combinations, then we can foretell the result.

Our knowledge of electrical action in this respect resembles our knowledge of gravitation action. The only think quite certain about the *reason* why a body falls to the ground is that we do not know it; and yet astronomical phenomena can be predicted with marvellous accuracy. I mention the analogy, since some people fancy because the answer to that oft-repeated question "what is electricity?" not only cannot be given exactly, but can only be guessed at in the haziest way, even by the most able, that, therefore, all electric action is haphazard. As well might the determinations of a ship's latitude at sea be regarded as a mere game of chance, because we have not even a mental picture of the ropes that pull the earth and sun together.

This power of producing an action at a distance of many yards, or it may be many miles, by the aid of electricity without the visible motion of any substance in the intervening space is by no means new. It is the essence of the electric telegraph, and electric transmission of power was employed by Gauss and Weber when they sent the first electric message. I am transmitting power electrically whether I now work this small model needle telegraph instrument, or whether I turn this handle and set in motion that little electric fan. (Experiment shown.)

But until about ten years ago the facility that electricity gave for producing signals almost instantaneously at a great distance was the main thing thought of. The electric power consumed for sending the telegraph messages was so small, the amount of power lost *en route* comparatively so valueless, that the telegraph engineer had no need to trouble himself with those considerations that govern us to-day when we are transmitting power large enough to work a factory or an electric tramway. Although there are as many as 22,560 galvanic cells at the Central Telegraph Office, London, which cost some thousands annually to keep in order, what is that compared with the salaries of all the 3,089 superintendents, assistants, telegraph clerks, messengers, and the maintenance of the 1,150 telegraph lines that start from the Central Office?

In all the last three of the systems on my list some form of power, such as flowing water or the potential energy stored up in coal, wood, zinc, or other fuel has initially to be utilised, this power is given to some form of air, water, or electric pump, which transfers the air power to the air, water, or electricity, by which it is conveyed to the other end of the system. There it is reconverted into useful mechanical power by means of an air, water, or electro-motor.

You will observe that I class together air, water, and electricity; but that I do not mean to imply that electricity is a fluid, although in many respects it acts like a fluid, like a fluid of very little mass, however, or, odd as it may seem, like a fluid moving extremely slowly, for electricity goes round sharp corners with perfect ease and without any of the phenomena of momentum possessed by rushing water. But what I particularly wish to impress on you by classing air, water, and electricity together is that electricity is not, as some people seem to think, a something that can be burnt or in some way used up and so work got out of it. Electricity is no more a source of power than a bell wire is; electricity is a marvellously convenient agent for conveying a push or a pull to a great distance, but it is not by the using up of the electricity that electric lights burn or that electro-motors revolve. It is by the electricity losing pressure, exactly as water loses head when turning the miller's wheel as it flows down hill, that work is done electrically.

This model shows in a rough symbolical way what takes place in the transmission of power whether by air, water, or electricity (model shown). The working stuff, whichever of the three it may be, is first raised in pressure and endowed with energy, symbolised by this ball being raised in the model from its original position to a higher one; it then gradually loses pressure as it proceeds along the tube or wire which conveys it to the other end of the system, the loss of pressure being accompanied by its giving up power to the tube or wire and heating it. This is shown in the model by the ball gradually falling in its course. At the other end there is a great drop of pressure corresponding with a great transference of power from the working stuff to the motor, and finally it comes back along the return pipe or wire, losing, as it returns, all that remains of the pressure given to it initially by the pump. The ball has, in fact, come back to its original level.

The problem of economically transmitting power by air, water, or electricity is the problem of causing one or other of these working stuffs, air, water, or electricity, to economically perform the cycle I have described.

In each of the four stages of the process (1) transference of power to the working substance at the pump, (2) conveyance of power to the distant place, (3) transference of power from the working substance to the motor at the distant place, (4) bringing back the working substance, there is loss of power, and the efficiency of the arrangement depends on the amount of these four losses. The losses may be shortly called (1) loss at pump, (2 and 4) loss on the road, (3) loss at the motor.

Until 1870, the pump most generally employed for pumping up electricity and giving it pressure was the galvanic battery, scientifically an extremely efficient converter of the energy in fuel into electric energy, only unfortunately, the only fuel a battery will burn is so expensive. A very perfect fireplace, in which there was very complete combustion and very little loss of heat, but which had the misfortune that it would only burn

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the very best wax candles, would be analogous with a battery. The impossibility of using zinc as fuel to commercially work electro-motors has been known for the last half century, and the matter was very clearly put in an extremely interesting paper "On Electro-Magnetism as a Motive Power," read in 1857 by Mr. Hunt before the Institution of Civil Engineers, a copy of which has been kindly lent me by Dr. Silvanus Thompson. "Prof. William Thomson (Glasgow)"—I quote from the discussion on the paper—put the matter very pithily by showing that, even if it were possible to construct a theoretically perfect electro-motor, the best that could be hoped for, if it worked with a Daniell's battery, would be the production of a 1 h.p. by the combustion of 2lb. of zinc per hour, whereas with a good actual steam-engine of even thirty years ago, 1 h.p. could be produced by the combustion of exactly the same weight of the much cheaper fuel—coal. This argument against the commercial employment of zinc to produce electric currents is irresistible, unless—and this is a very important consideration, which is only beginning to receive the attention it deserves—unless, I say, the compound of zinc formed by the action of the battery can be reduced again to metallic zinc by a comparatively inexpensive process, and the zinc used over and over again in the battery. If the compound of zinc obtained from the battery be regarded as a waste product, then it would be much too expensive to work even theoretically perfect electromotors, if they were existent, by consuming zinc. Suppose, however, a process be devised by means of which burnt zinc can be unburnt with an expenditure comparable with the burning of the same weight of coal, then it might be that although coal would still form the basis of our supply of energy, the consumption of zinc batteries might be an important intermediary in transforming the energy of coal economically into mechanical energy.

While, then, some experimenters are aiming at possibly increasing the working power of a ton of coal to eight times its present value by earnestly seeking for a method of converting the energy it contains directly into electric energy without the intervention of a wasteful heat-engine, it should not be forgotten that in the cheap unburning of oxidised metal may lie another solution.

The solution of this latter problem is quite consistent with the principles of the conservation and dissipation of energy, since the heat required to theoretically unburn 1lb. of zinc is only one-seventh of that given out by the burning of 1lb. of coal. Further, it involves no commercial absurdity like that found in the calculations given in the prospectuses of many primary battery companies which are based on zinc oxide, a material used in the manufacture of paint, maintaining its present price even if thousands of tons were produced. Unless all those who use primary batteries on this expectation intend to have the painters doing up their houses all the year round, they will find themselves possessed of the stock-in-trade of an oil and colourman on a scale only justified by a roaring business in paint.

Now, about waste No. 3—the waste of power at the motor. That also is gone into fully in the discussion in Mr. Hunt's paper, and Mr. Robert Stephenson concluded that discussion by remarking: "That there could be no doubt, from what had been said, that the application of voltaic electricity, in whatever shape it might be developed, was entirely out of the question, commercially speaking. . . The power exhibited by electro-magnets extended through so small a space as to be practically useless. A powerful electro-magnet might be compared—for the sake of illustration—to a steam-engine with an enormous piston, but with an exceedingly short stroke. Such an arrangement was well known to be very undesirable." And this objection, made with perfect justice against the electro-motor of thirty years ago, might also have been made to all the machines then existing for the mechanical production of electric currents.

I have two coils of wire at the two sides of the platform, joined together with two wires. I move this magnet backwards and forwards in front of this coil, and you observe the magnet suspended near the coil begins to swing in time with my hand (experiment shown). Here you have, in its most rudimentary form, the conversion of mechanical power into electric power, and the reconversion of electric power into mechanical power; but the apparatus at both ends has the defects pointed out by Mr. Hunt and all the speakers in the discussion on his paper—the effect diminishes very rapidly as the distance separating the coil from the moving magnet increases.

As long as electro-motors, as well as the machines for the production of electric currents, had this defect the electric transmission of power was like carrying coal to Newcastle in a leaky waggon. You would pay at least 16s. for your coal at Bath, lose most of them on the way, and sell any small portion that had not tumbled out of the waggon for, say, 2s. a ton at Newcastle, a commercial speculation not to be recommended.

A very great improvement in electric motors was made by Pacinotti in 1860; but although his new form of electro-motor was described in 1864 it attracted but little attention, probably because any form of electro-motor, no matter how perfect, was commercially almost useless until some much more economical method of producing electric currents had been devised than the consumption of zinc and acids. Pacinotti's invention removed from motors that great defect that had been so fully emphasised by the various speakers at the reading of Mr. Hunt's paper in 1857. When describing his motor in the *Nuovo Cimento*, in 1864, he pointed out that his principle was reversible, and that it might be used in a mechanical current generator. This idea was utilised by Gramme in 1870, who constructed the well-known Gramme dynamo for converting mechanical into electric power, a machine far more efficient than even Pacinotti had contemplated, and gave the whole subject of electrical engineering a vigorous forward impulse. Every subsequent maker of direct-current dynamos, or motors, has followed Gramme's example in utilising the principle devised by Pacinotti, which was as follows: In all the early forms of dynamos and motors there were a number of magnets and a number of coils of wire, the magnets moving relatively to the coils, or the coils relatively to the magnets, as you see in this rather old specimen of alternate-current dynamo. To produce magnetism by a large number of little magnets is not economical, and Pacinotti's device consisted in arranging a number of coils round a ring in the way shown in the large wooden model (model shown) so that they could all be acted on by one large magnet. Instead of frittering away his magnetism, Pacinotti showed how it could be concentrated, and thus he led the way to dynamos and motors becoming commercial machines. Pacinotti's science, engineered by Gramme, not only made electric lighting commercially possible, but led to electricity being used as a valuable motive power. It was in their work that the electric transmission of power in its modern sense sprang into existence.

Quite recently an improvement in the same direction has been introduced into alternate current dynamos by Mr. W. N. Mordey, for he has replaced the many magnets of the ordinary alternate current dynamos with one large magnet, and so, with his alternator, weighing 41cwt., which you see in this hall, he has succeeded in obtaining, at a speed of 650 revolutions per minute, at output of 53·6 h.p., with a high efficiency.

It may be convenient to mention at this stage the very valuable work that has been done by the Doctors Hopkinson, Mr. Crompton, Mr. Kapp, and others in the improving dynamos and motors by applying scientific principles in the construction of these machines. Were I lecturing on dynamos and motors instead of on the electric transmission of power I would explain to you how by putting more iron into the rotating armature, as it is called, and less wire on it, by shortening the stationary magnet, and, generally, by concentrating the magnetic action, these constructors have raised the commercial efficiency of these machines to actually as high as between 93 and 94 per cent.; further, how, by recognising the force of the general principles laid down by Prof. Perry and myself as to the difference that should exist in the construction of a motor and a dynamo, Messrs. Immisch have succeeded in constructing strong durable electro-motors weighing not more than 62lb. per effective horse-power developed.

The subject is so entrancing to me, the results commercially so important, that I am strongly tempted to branch off, but the inexorable clock warns me that I must concentrate my remarks, as they have concentrated the magnetic action.

Eighty-seven and a half per cent. of the power put into an Edison-Hopkinson dynamo has actually been given out by the motor spindle when 50 h.p. was being transmitted. How does this compare with the *combined* efficiences of an air-pump and an air-motor, or of a water-pump and a water-motor? I understand that in either of these cases 60 per cent. is considered a very satisfactory result. As far, then, as the terminal losses are concerned, electric transmission of power is certainly superior to air or water transmission.

The next point to consider is the loss of power on the road between the dynamo at the one end and the motor at the other. This problem was, perhaps, seriously attacked for the first time in the discussion of a paper read by Messrs. Higgs and Brittle at the Institution of Civil Engineers in 1878, and that problem was considered in some detail theoretically and experimentally at the lecture I gave during the meeting of the British Association in Sheffield in the following year. It was then shown that since the power developed by the generator and motor depended on the product of the current into the electric pressure, while the loss when power was transmitted through a given wire depended on the square of the current, and was independent of the electric pressure, the economical transmission of power by electricity on a large scale depended on the use of a very large electric pressure and a small current, just as the economic transmission of much power by water depended on the use of a very large water pressure and a small flow of water. At that time it was not thought possible to construct a small dynamo to develop a very large electric pressure, or potential difference, as it is technically called, and, therefore, it was proposed to join up many dynamos in series at the one end, and many lamps or electric motors in series at the other, and to transmit the power by a very small current, which passed through all the dynamos and all the lamps in succession one after the other.

You have an example to-night of the realisation of this principle in the 15 arc lamps that are all in series outside this drill-hall, and are worked with a small current of only 6·8 amperes as

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indicated in the wall diagram, and a further example in the thirty arc lamps at the Bath Flower Show, which are also all worked in series with the small current passing through them; but it is known now how to produce a large potential difference with a single dynamo so that a single Thomson-Houston dynamo belonging to Messrs. Laing, Wharton and Down supplies the current for each of the two circuits.

The electric pressure, or potential difference, between the terminals of any arc lamp is not high, but it *is* between the main wires near the dynamo as well as between these wires and the ground. How far does this lead to the risk of sparks or unpleasant shocks? That is a point that can be looked at in a variety of ways. First, there is the American view of the matter, which consists in pointing out to people exactly what the danger is (if there be any), and training them to look out for themselves. Let ordinary railway trains, say the Americans, run through the streets, and let horses learn to respect the warning bell. Next, there is the semi-paternal English system, which cripples all attempts at street mechanical locomotion because we are conservative in our use of horses, and horses are conservative in their way of looking at horseless tramcars. Lastly, there is the foreign paternal system which, carried to its limit, would prohibit the eating of dinners because some people have at some time choked themselves, and would render going to bed a penal offence because it is in bed that most people have died.

We laugh a good deal at the rough-and-ready manner adopted on the other side of the Atlantic. The Americans, no doubt, are very ignorant of the difficulties that properly-minded people would meet with; but it is a blissful ignorance where "it is folly to be wise. Every English electrician who has travelled in America comes back fully impressed with their enterprise and their happy-go-lucky success. They have twenty-two electric tramways, carrying some 4,000,000 passengers annually, to our four electric tramways at Portrush, Blackpool, Brighton, and Bessbrook. Why, New York City alone, Mr. Reckenzaun tells me, possesses 300 miles of ordinary tramway track, and Philadelphia City 430 miles, so there is more tramway line in these two cities than in the whole of the United Kingdom put together. Now, there would be no difficulty in proving to anyone unfamiliar with railway travelling that to go at fifty miles an hour round a curve with only a bit of iron rail between him and eternity, would be far too risky to be even contemplated. And yet we do go in express trains, and even eighty miles an hour is beginning to be considered not to put too great a demand on the funds of life-insurance companies. The American plan of basing a conclusion on experience rather than on anticipation is not a bad one, and if we follow that plan, then taking into account that there are 75,000 arc lights alight every night on the Thomson-Houston high-potential circuits throughout the world, and the comparatively small number of people that have suffered in consequence (not a single person, I am assured, outside the company's staff), we are compelled to conclude that high potential now is what thirty miles an hour was half a century ago—uncanny rather than dangerous.

But it is possible to use a very large potential difference between the main wires by means of which the electric power is economically conveyed a considerable distance, and transformed into a very small potential difference in the houses where it is utilised. An electric transformer is equivalent to a lever, or wheel and axle, or any other of the so-called mechanical powers. You know that a large weight moving through space distance can raise a small weight through a large distance. There is no gain in the amount of work, but only a transformation of the way in which the work is done. A large weight moving through a small distance in analogous with a high potential difference and a small current, while a small weight moving through a large distance is analogous with a small potential difference and a large current, and an electric transformer is for the purpose of effecting the transformation with as little loss as possible, so that what is lost in potential difference may be all gained in current. Electrical transformation may be effected by (1) alternate current transformers, (2) motor-dynamos, (3) accumulators or secondary batteries, and (4) direct current transformers.

Of these apparatus the oldest by far is the alternate current transformer, as it is merely the development of the classical apparatus invented by Faraday in 1831, and familiar to many of you as the Ruhmkorff or induction coil. A combination of a motor and dynamo was suggested by Gramme in 1874. Accumulators are the outcome of Planté's work, while direct current transformers are quite modern and not yet out of the experimental stage.

After studying the literature of this subject it appears, as far as I have been able to judge, that the first definite proposal to use a high potential difference in the street mains and transform down to a low potential difference in the houses was made in the lecture given by me at the meeting of the British Association in Sheffield in 1879, on which occasion I explained and showed in action the motor-dynamo principle suggested by Prof. Perry and myself. The apparatus on the platform is not unlike that shown on the former occasion; an Immisch motor working at 500 volts, and with a current of 6·8 amperes, is geared direct to a Victoria brush dynamo giving five times that current, and we will now use this larger current to produce an electric fire (experiment shown). Messrs. Paris and Scott have combined the motor and dynamo into one machine, which they have kindly lent me, and by means of which we are now transforming about 700 volts and 6·8 amperes into 100 volts, and about 40 amperes used to light that group of incandescent lamps and work these motors (experiment shown).

Lastly, here is a working illustration of the double transformation proposed by MM. Deprez and Carpentier in 1881, by means of which, while the potential difference between the mains may be 2,000 or 10,000 volts if you like, not merely is the potential difference in the house so low that you could hardly feel anything if you touched the wires, but, in addition, there is the same security against shocks in the dynamo-room. This alternate current machine is producing about 50 volts, which is transformed up to 2,000 volts by means of this transformer. At the other end of the platform by means of a similar transformer the 2,000 volts is transformed down again to 50 volts employed to light that cluster of low voltage incandescent lamps (experiment shown). I have to thank the Anglo-American Brush Company for the loan of the apparatus.

(To be continued.)

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ended September 7 amounted to £4,863.

Western and Brazilian Telegraph Company.—The traffic receipts of the Western and Brazilian Telegraph Company for the past week, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £4,011.

Great Northern Telegraph Company.—The Great Northern Telegraph Company's receipts for the month of August were £23,200, making a total from January 1 of £179,200, against £174,120 for the same period of 1887 and £169,960 in 1886.

Cuba Submarine Telegraph Company.—The number of messages passing over the lines of the Cuba Submarine Telegraph Company during August was 3,507, estimated to produce £2,800, against 2,983 messages, producing £2,280, in the corresponding month. The receipts for May, estimated at £3,300, realised £3,337.

Companies of the Month.—The following electrical companies have been registered during the past month:—

Barnet and District Electric Supply Company, £10 and £1 shares	£5,000
Bedford Electric Light Company, £1 shares	15,000
Electrical Accumulator Association, £10 shares	10,000
Lineff Electric Traction and Lighting Syndicate, £1 shares	10,000
Laurence, Paris and Scott, £10 shares	30,000
Rees' Miners' Patent Safety Electric Lamp Company, £5 shares	50,000

Manchester Edison-Swan Company. — The annual report of the Directors of the Manchester Edison-Swan Company, Limited, presented to the shareholders at their last meeting, states that the net profit, including last year's balance, amounts to £1,781. 15s. 3d., which it is proposed to appropriate as follows: To payment of dividend at 5 per cent. per annum, £1,000; to reserve fund, £500; balance to be carried forward, £281. 15s. 3d.; total, £1,781. 15s. 3d. In accordance with the special resolutions passed on the 5th September, 1887, and confirmed on the 3rd October, 1887, the name of the company has been changed from the Manchester and District Edison Electric Light Company to the Manchester Edison-Swan Company, Limited, and a reduction of the capital has been effected by canceling capital which has been lost, to the extent of £1 per share upon each of the 20,000 A shares issued, and by reducing the nominal amount of all the A shares in the company's capital from £10 to £9 per share. The company's stock and plant have now been depreciated to their present market value, and all losses written off, thus leaving the assets of the company in a sound condition, besides enabling the Directors to place £809. 18s. to a depreciation fund for future contingencies.

PROVISIONAL PATENTS, 1888.

SEPTEMBER 1.

12,592. **An improved means or method of attaching incandescent electric lights to gas brackets or other gas fittings.** Claude Hamilton, 17, Hope-street, Glasgow.

12,593. **Improvements in recording and reproducing sounds, and in means applicable therefor.** George Edward Gouraud, 191, Fleet-street, London, E.C. (Thomas Alva Edison, United States.)

12,594. **Improvements in phonographs.** George Edward Gouraud, 191, Fleet-street, London, E.C. (Thomas Alva Edison, United States.)

12,609. **Improvements in or relating to electrical locks.** William Phillips Thompson, 6, Lord-street, Liverpool. (Ernest Lémonon, France.)

12,620. **Electric secondary battery plates.** Charles Marson, 5, East Terrace, Queen's-road, Battersea, Surrey.

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SEPTEMBER 3.

12,703. **An improved voltaic battery.** George Thomas Jolland, 54, Fleet-street, London, E.C.

12,705. **Improvements in apparatus for the transmission of power.** Otto Krell, 323, High Holborn, Middlesex.

12,706. **Improvements in storage battery plates.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles David Paige Gibson, United States.) (Complete specification.)

SEPTEMBER 4.

12,727. **The electric break appliance.** G. Stibbe, acting for Edouard Dubied and Co., Convet, Suisse.

12,740. **Improved apparatus for electrically indicating variations of water level in rivers, aqueducts, mines and the like.** Wallace Fairweather, 62, St. Vincent-street, Glasgow. (Heinrich Christian Spohr, Germany.)

12,754. **Improvements relating to electric bells and to indicating apparatus for use in connection therewith.** Henry Harris Lake, 45, Southampton-buildings, London. (William Humans, United States.) (Complete specification.)

12,759. **An electric-meter or apparatus for recording the passage or consumption of electricity.** Francis Teague, Crown-yard, Stanhope-street, Euston-road, N.W.

12,761. **Improvements in dynamo electric machines.** Addison G. Waterhouse, 321, High Holborn, W.C. (Complete specification.)

12,767. **Improvements in dynamo-electric machines.** William Harding Scott, 64, Hall-road, Lakenham, Norwich.

12,798. **Improved electrical sounding apparatus.** Pedro Vigil and Juan N. Revueltas, 53, Chancery-lane, London.

SEPTEMBER 5.

12,817. **Immediately stopping a steam engine by means of electricity from a distance; may be called "The electric engine stopper."** Edward Dixon, Princess-avenue, Hull.

12,828. **Improvements in electric incandescent lamps.** Félix D'Arc, 57, Chancery-lane, London.

12,832. **Improvements in conductors for armatures of dynamo electric machines.** Frederik Vilhelm Andersen, 3, Elm-court, Temple, London, E.C.

12,856. **Improved apparatus for converting electrical currents.** Carl Zipernowsky and Max Deri, 28, Southampton-buildings, Chancery-lane, London, W.C.

12,858. **Improvements in the distribution of electrical energy.** Carl Zipernowsky and Max Deri, 28, Southampton-buildings, Chancery-lane, London, W.C.

SEPTEMBER 6.

12,887. **An improvement in voltaic cells.** Robert Henelade Courtenay, 78, Wool-exchange, Coleman-street, London, E.C.

12,907. **Improvements in dynamo electric machines.** Thomas Parker and William Lowrie, 433, Strand, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

SEPTEMBER 14, 1887.

12,437. **Improvements in and connected with dynamo electric machines.** Rookes Evelyn Bell Crompton and James Swinburne, Arc Works, Chelmsford.

SEPTEMBER 21, 1887.

12,830. **An improved regulating device for use in electric arc lamps and for other purposes.** William Robert Lake, 45, Southampton-buildings, London. (Otto Heinrich Louis Lindemann, Germany.)

SEPTEMBER 23, 1887.

12,924. **Improvements in the manufacture of incandescent electric lamps and of carbon rods therefor.** Geminiano Zanni, 45, Southampton-buildings, London.

NOVEMBER 8, 1887.

18,030. **Improvements in thermo-electric batteries.** Louis Charles Emile Lebiez and Paul Louis Verchére, 55 and 56, Chancery-lane, London. (Received 5th March, 1888, antedated 8th November, A.D. 1887. Under International Convention.)

NOVEMBER 17, 1887.

15,754. **Improvements in the electrolytes of secondary voltaic batteries.** William Joseph Starkey Barber-Starkey, 70, Market-street, Manchester.

FEBRUARY 20, 1888.

2516. **A new or improved apparatus or inductometer for measuring the intensity of a magnetic field.** George Mist, 46, Lincoln's-inn-fields, London, W.C.

JULY 10, 1888.

9991. **Improvements in magneto-electric apparatus.** William Robert Lake, 45, Southampton-buildings, London, W.C. (William Heemans, United States.)

JULY 28, 1888.

10,954. **Improvements in or connected with dynamo electric machines.** Ernest Heinrich Geist, 433, Strand, London.

AUGUST 4, 1887.

11,338. **Improvements in telephone line circuits.** Léon Kelner, 24, Southampton-buildings, London, W.C.

SPECIFICATIONS PUBLISHED.

1887.

10,611. **Electrical batteries.** R. P. Milburn. 6d.

10,833. **Electric lamps.** F. R. Boardman. 8d.

10,838. **Electrical switches.** F. L. Rawson and W. White. 8d.

10,952. **Dynamo electric machines, &c.** L. Anspach and L. Gerard. 8d.

11,802. **Incandescent lamps.** A. Shippey. 8d.

12,203. **Dynamo electric machines.** T. L. Hemming. 8d.

13,320. **Electric regulators.** J. G. Statter and S. L. Brunton. 8d.

13,510. **Microphones.** W. Genest. 8d.

13,558. **Casings for electrical conductors, &c.** P. Everitt and P. R. Allen. 8d.

14,024. **Secondary batteries.** N. De Bernados. 8d.

14,029. **Electrical tramways and railways.** F. C. Allsop. 11d.

1644. **Recording and reproducing sounds.** T. A. Edison. (Third edition.) 1s. 1d.

1888.

5681. **Electrical switches.** C. S. Snell. 8d.

9981. **Recording and reproducing sounds.** J. Y. Johnson (The Volta Graphophone Co.). 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday	Dividend.		Name.	Paid.	Price. Wednesday.
2 July	4%	African Direct 4%	100	101	30 April	5%	Gt. Northern 5% Deb., '83.	100	109
12 Feb.	1/2	Anglo-American Brush E.L.	4	3	27 July	10/0	India Rubber, G. P. & Tel.	10	16¾
12 Feb.	2/0	— fully paid	5	4	11 May	37/6	Indo-European	25	39
27 July	1%	Anglo-American	100	42½	30 May	3/0	London Platino-Brazilian...	10	6½
27 July	2%	— Pref.	100	71¼	16 Mar.	5%	Maxim Weston	1	⅛
12 Feb., 85...	5/0	— Def.	100	15¼	30 May	2½%	Orientsl Telephone	11	1/16
28 June	3/0	Brazilian Submarine.....	10	13⅛	26 April	4/0	Reuter's	8	8
14 June	1/0	Con Telephone & Main ...	1	¼	.....	...	Swan United	3½	2¼
10 Aug.	9/0	Cuba	10	13¾x	10 Aug.	13½%	Submarine	100	140x
10 Aug.	10/0	— 10% Pref.	10	19½	15 Oct.	6%	Submarine Cable Trust ...	100	97
28 Mar.	2/2½	Direct Spanish	5	4	12 July	12/0	Telegraph Construction ...	12	39½
28 Mar.	5/0	— 10% Pref.	5	10½	2 July	6/0	— 6%, 1889	100	105
27 July	2/0	Direct United States	20	9½	12 July	10/0	United Telephone	5	13½
27 July	4/6	Eastern	10	12¼	27 July	3/0	West African	10	8
27 July	3/0	— 6% Pref.	10	15	1 Mar.	5%	— 5% Debs.	100	99
1 Aug.	5%	— 5%, 1899	100	110	12 July	4/0	West Coast of America ...	10	7
26 April	4%	— 4% Deb. Stock	100	108	30 June	8%	— 8% Debs.	100	115
12 July	2/6	Eastern Extension, Australasia & China.....	10	18⅛	11 May	9/0	Western and Brazilian.....	15	12¼
1 Aug.	6%	— 6% Deb., 1891	100	107	11 May	6/10½	— Preferred	7½	7
2 July	5%	— 5% Deb., 1900	100	104	11 May	2/1½	— Deferred.....	7½	5½
2 May	5%	— — 1890	100	102	1 Aug.	6%	— 6% A	100	109
2 July	5%	Eastern & S. African, 1900	100	103	1 Aug.	6%	— 6% B	100	107
28 Mar.	8/8	German Union	10	9½	.....	...	West India and Panama ...	10	1⅜
10 Aug.	3/0	Globe Telegraph Trust.....	10	7⅛	30 May	10/0	— 6% 1st Pref.	10	12½
10 Aug.	3/0	— 6% Pref.	10	14x	13 May, '80...	...	— 6% 2nd Pref.	10	9
30 April	5/0	Great Northern.....	10	14	2 May	7%	West Union of U.S.....	$1,000	123
					1 Mar.	6%	— 6% Sterling	100	105

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NOTES.

Kansas Electric Railway.—The Thomson-Houston Company are constructing a long line of electric road at Kansas City on their now well-tried system.

Algeria.—The municipality of Orleansville, Algeria, has put up to tender the installation and carrying on of a central station for the public and private lighting of that town.

Birkenshaw.—The ratepayers have held a meeting to consider the gas question, being greatly dissatisfied with the present light at Birkenshaw. The present public lights are to be discontinued.

Kensington and Knightsbridge.—The Kensington Court Electric Lighting Company has changed its name to "Kensington and Knightsbridge," and is now extending its operations into the Knightsbridge district.

Crude Petroleum.—Crude petroleum is extending its use as fuel. A barrel of Lima oil, which cannot be refined like other oil, is said to be equal to a ton of fuel. At Lima it is used to supply power for an electric railway.

Heanor.—A committee has been formed to consider the purchase of the local gas works, and to consider the question of electric light. The chairman thought that in a short time electric light would be within easy distance.

Burning the Eyes.—The acute pain in the eyes sometimes experienced from looking at arc lights is thought to be often due to the smoke which comes from the carbons. The copper coating seems to give off a poisonous vapour which affects the sight.

Errata.—In Lord Rayleigh's paper, given on pp. 227-8, the following corrections should be made: First line read *Roiti* instead of *Roite;* and end of first paragraph read *interference* instead of *influence;* in the note marked * p. 228, read *five*, instead of *fine.*

Common Sense Rule.—Mr. S. S. Wheeler recommends this rule for the regulation of arc lights, that "an arc lamp within the reach of any man's umbrella is hung too low," a common sense suggestion which should recommend itself everywhere.

Cure for Writer's Cramp.—A few gentle shocks from a small coil are said to cure the cramp of the muscles which follow continual use of the pen. The battery and coil is a fixture in the office equipments of a recording office of the Superior Court, Baltimore.

The Otto Gas Engine.—It is announced that M. Otto, the inventor of the gas-engine, has just constructed a new machine which automatically prepares its own gas by means of the Dowson apparatus. The new model is of 8 h.p., and only consumes 2lb. of coal per horse-power hour.

Steering the Dog-Cart.—The Sultan's dog-cart steers the other way to a bicycle, by reason of its geared wheel, as our contemporary's representative found to his cost last week, when he ran the vehicle through the rails, over the benches, and into the bank, and nearly spoilt the whole show.

Long-distance Telephony.—The Postal and Telegraph Administration of Austria have commenced the construction of a long-distance telephone line between Vienna and Prague. The telephone line between Alexandria and Cairo will shortly be completed, the last of the apparatus having arrived.

Paris.—The Gymnase Theatre has been lighted with electric light. In this installation 56 Schenck-Farbaky accumulators are used in two batteries, which together give an output of 320 amperes. These are charged by two Thury dynamos. The installation comprises 883 Khotinsky incandescent lamps.

Noise from Commutators.—The noise of the brushes on the commutator is sometimes uncomfortably noticeable. If this is ever the case, let the commutator be occasionally slightly greased with vaseline, and a box with wadding or slag wool, under a lining, be fitted over the brushes. This will reduce the noise to a minimum.

Free Telephony.—By the courtesy of the directors of the Western Counties and South Wales Telephone Company, the whole of the section-rooms during the Bath meeting of the British Association were telephonically connected, for free use of the visitors, with the reception-room and with all important places in the neighbourhood.

Physical Society, Glasgow.—The 1888–9 session of the Physical Society of the Glasgow University commenced on September 14, when the president, Mr. M. Maclean, M.A., delivered his address on "Electric Hypotheses." The next meeting is on September 28, when a paper, on "The Electric Fishes," will be read by Prof. M'Kendrick, F.R.S.

The May Island Electric Light.—Captain Boldt, of the Danish mail steamer "Thyra," which arrived at Granton on Tuesday afternoon from Copenhagen, reports having sighted the May Island light, Edinburgh, at half-past three o'clock in the morning, distant sixty-one nautical miles. This is the highest recorded distance at which the reflection of the light has been observed.

Aberdeen.—The Aberdeen *Herald and Weekly Free Press* has just moved into large new offices. The whole establishment has been supplied with the electric light, which is now coming very rapidly into use in establishments where much artificial light is required. The dynamo is driven by a powerful engine supplied by the well-known firm of Marshall, Sons and Co., Gainsborough.

Electric Omnibus.—It is not generally known yet, but we learn that there is running in the streets of London in the early hours—from three to five nearly every day of the week—an electric omnibus, for the purpose of testing the practicability of this invention in the City streets. The route has been by Hyde Park, Oxford-street, Holborn, Fetter-lane, Strand, to the Hotel Metropole. Further particulars will be forthcoming shortly.

Lighting in Derby.—Messrs. Rowbotham and Godwin, Iron Gate Works, Derby, write to say that two years ago they fixed 40 incandescent lamps and one 2,000 c.p. arc lamp for Messrs. W. D. Borraill and Co., and have also fitted 400 incandescent lamps for Messrs. W. Rickard and Co., electric wire manufacturers, so that they are the first firm to introduce the electric light into Derby. They are at present lighting up the premises of Mr. T. E. Yeomans, of Derby, and are among those tendering for the public lighting of the streets of that town.

The Sun Motor.—In the latest form of Captain John Ericson's perfected sun motor, recently described in *Nature*, flat surfaces and parallel rays for purposes of reflection are adopted for utilising the sun's heat instead of curved surfaces and converging rays. He states that a surface of reflecting mirrors of 100 square feet presented at right

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angles to the sun (at noon) in the latitude of New York, during the summer, develops a mechanical energy reaching 1,850,000 foot pounds per hour, and asserts that the sun power can be made steady and constant.

Madrid.—Madrid is shortly to have a large public central station for supply of electric light. A company, under the name of "La Luz Natural," has been formed by local capitalists, and the installation, consisting of 1,000 h.p., is already in progress. The wires will be overhead. The charge is fixed at a rate equal to ½d. per lamp-hour of 16 c.p., the replacement of lamps being at the charge of the consumer. The greater number of the theatres in Madrid have arranged to be connected with this source of supply, the Theatre Royal alone being excepted.

Cheltenham.—The borough surveyor has reported that the following sites might be utilised for the erection of the necessary buildings and apparatus for an electric light installation at Cheltenham: 1, water works pumping station and land in Sandford Mead; 2, land and buildings at Barrett's Mill; 3, land at the Central Depot; 4, the south-west portion of the Cattle Market; or 5, land adjoining the site of the proposed refuse destructor. The sites No. 3 and 5 would have the advantage of railway communication. Of these sites the committee consider those of Barrett's Mill and the Central Depot the most suitable.

Lowrie-Hall System.—The fact announced by us a short while ago that Hammond and Co. are completing a central station plant, to be sent to America, naturally excited some comment upon that side of the ocean. We add a few further particulars. The plant is for a town in the Argentine Republic, South America, and consists of alternate-current dynamos and transformers on the Lowrie-Hall system, fitted with their automatic E.M.F. regulator for alternate currents, regulating to within one volt, together with a complete system of switchboards and special meters for measuring the currents. The plant will be despatched in a few weeks.

Electric Photography.—It is stated that the latest and strangest case of the uses of applied science recently occurred near Perigeux, France, where five persons were imprisoned by the caving-in of a quarry wall, and there was no means at hand to rescue them. To find out where they were, a shaft 12in. in diameter was bored, down which was slid a tube, near the end of which was a small camera surrounded by a battery of electric lights. With this apparatus a number of negatives were taken, and the effect of the disaster shown, even to the faces of two corpses. It was thus known that the men were dead, and that efforts to succour them would be useless.

Grand Theatre, Liverpool.—A fine theatre installation is being carried out by Messrs. A. H. Fletcher and Co., of Liverpool, at the Grand Theatre in that town. The installation will be worked at present by a 50-h.p. Otto gas-engine in the basement. The dynamos are supplied by Messrs. J. G. Statter and Co. The theatre will be lighted throughout with incandescent lamps varying from 1,000 to 16-c.p. at 100 volts. The limelight will be replaced by an arc light projector by Messrs. Statter, and arrangements are made for raising and lowering the brilliancy of the light for stage usage. Ventilating fans driven by small electromotors will be placed in the auditorium and refreshment-rooms.

Municipal Lighting of Paris.—The Municipal Council of Paris are intending to hold three open competitions for the construction and installation of (1) dynamos and apparatus, (2) engines, and (3) boilers. Plans and prospectuses are to be seen at the Hotel de Ville (Direction des Travaux, 2 division, 3 bureau), Paris. Competitors must send in, before the 10th of October next, to "M. le directeur de la Voie publique et des Promenades, avenue Victoria 4," certificates stating the capabilities and giving particulars of similar work already undertaken. Two committees will meet at the Hotel de Ville on 25th October to deal with dynamos and apparatus, and on 26th October with engines and boilers.

Electric Sugar.—A meeting of the shareholders of the Electric Sugar Refining Company was held in Liverpool on Sept. 17th, to hear the report of Mr. R. Roberts, of Birmingham, who was delegated to visit the factory at New York. He stated that the trial had proved in every way satisfactory. There were four granulators, and with one of these at work 150 barrels had been filled with refined sugar in an hour and ten minutes. In a few weeks the remaining granulators would be working, and the factory turning out sugar at the rate of 5,000 barrels a day. The shareholders present expressed themselves satisfied with the progress made. After their recent phenomenal advance from £20 to over £100 a share, Electric Sugars have settled down between 85 and 90. The dealings in them continue to be very active, and the Liverpool papers now quote the price every day.

Wolverhampton.—The councillors of Wolverhampton, being dissatisfied with the gas, and having Messrs. Elwell-Parker on the spot, have asked these gentlemen their opinion with regard to lighting the town with electricity. They advise the corporation that they cannot at present recommend the lighting of the streets alone, owing to the length of the leads necessary, and the consequent labour in laying down. But Messrs. Elwell-Parker are of opinion that if street lighting were combined with domestic lighting, a 40,000 lamp installation could successfully compete with gas in Wolverhampton. After a discussion the gas contract was renewed with certain restrictions, but Mr. Alderman Gibbons did not believe that the town would ever secure relief until a competition was started in the shape of electric lighting, and thought the corporation should start their own plant.

Mining Lamps.—In the paper of Mr. Watts, read at the British Association, reference was made to a miners' lamp issued by the Portable Electric Lamp and Power Syndicate, and we are able to give the following further information about the lamp. The 2-cell miners' lamp gives a light for eighteen hours equivalent to one candle, and weighing four-and-a-half pounds.

Average E.M.F. (in closed circuit for 12 hours)	3·75 volts.
Current through lamp	·323 ampere.
Power expended in external circuit	1·211 watts.
Capacity of negative element	7 amp.-hours.
Electrolyte used is dilute sulphuric acid.	
Specific gravity of the electrolyte	1·170
Weight of elements complete	1lb. 3oz.
„ negative element (lithanode)	6oz.
„ positive element (spongy lead)	2½oz.
Total height	8 inches.
Total diameter	4 inches.

Electro-Medical Apparatus.—Mr. K. Schall, of 55, Wigmore-street, W., sends us a very complete and well got-up little catalogue of all kinds of medical apparatus in which electricity is used. These include medical batteries for exciting Ruhmkorff coils, for the electrolysis of tuber-

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culous growths, for cauterisation, for supply of small electric lamps to be carried on the forehead in operations, and for illuminations of the cavities. It also includes numerous electrodes for the electric treatment of various parts of the body, designed by Dr. Apostoli, Prof. Erb, Dr. Boudet, Dr. Duchène, and others, also induction coils by Dr. Dubois-Reymond, Dr. Hedinger's large plunge battery, requiring filling only once every four to 12 months, static induction machines for what is called Franklinisation, and for the production of ozone. The list also includes galvanometers, rheostats, and other apparatus likely to be required by medical men.

Burning out the Telephones.—There seems a strange fatality about the telephone systems in some parts of America. We constantly notice reports in the transatlantic journals of thunderstorms playing mischief with the telephone wires, breaking them down and burning out the drops in the exchange. Two cases recently in Arkansas are of this nature, and another in which an old unused telephone set fire to a house. At St. Joseph, Missouri, over three hundred telephones were burnt out. New Orleans has also just suffered from a storm, the telephone and telegraph wires getting crossed with the electric light wires, causing destruction in all directions. The mischief seems sometimes to arise from the lightning, and often from crossing of the electric light wires, but it certainly seems strange that proper precautions are not taken by use of lightning arresters to guard against lightning, and by fuses, if necessary, to guard against accidental heavy currents.

Window Lighting.—Here is a tip for those who have to do with shop window lighting where incandescent lamps are used throughout. A shopkeeper had his window lighted with 16 c.p. incandescent lamps, but the effect was not much better than ordinary gas, and by far the greater proportion of the passers-by would not even notice that he had the electric light. "What!" he asked himself, "to have all the expense of the electric light and none of the credit? This will never do." He consulted an electrical friend, who gave him the following advice: "Your E.M.F. is 100, your lamps are 100 volt lamps; continue to use these in the shop itself, but in the window, where you want a more brilliant and attractive light, *use lower voltage lamps*—96, 90, or even 85. Never mind if they burn up a little faster—as they will—the extra expense will well repay itself in advertisement." This advice was followed, and from being a dull shop it is now the most brilliantly lighted, and a crowd of admiring sight-seekers constantly stop, attracted by the beauty and clearness of the lamps.

New Catalogue.—We have received from Messrs. B. Verity and Sons their new catalogue of electric fittings, which contains a very large number of illustrations of electroliers, brackets, shades, and other fittings designed specially to be used with incandescent lighting. Messrs. B. Verity and Sons have had a very large experience, and may therefore be supposed to have fairly gauged the public taste in this direction. They use for the construction of these fittings polished copper, copper and brass, and copper and silver work, and we understand that so great has been their success in this direction that they have been compelled to fit up a new factory, to be especially devoted to electric lighting work. The illustrations in this catalogue have been prepared by the Phototype Co., and the whole catalogue is very tastefully and handsomely got up. With regard to the designs themselves we believe that most, if not all, are due to Mr. S. Crichton Hannah, an artist who is rapidly taking a prominent place in the country, and who has exhibited at the Royal Academy the last two years.

The Whitehall Station.—Whitehall will be "up" early next week for the laying of the mains of the first large underground system of distributing electricity in London. Whitehall, being adjacent to Charing Cross and extending to Westminster, is the actual centre of London, and the metropolis can at any rate congratulate itself that public supply of electric lighting on a commercial scale has at last been inaugurated. The station itself has been in progress of installation by Messrs. Crompton and Co., of Chelmsford, for some time for the Whitehall Court Company, who have lately sold out to the recently-formed Metropolitan Electric Supply Company, who are shortly intending to undertake the public supply on an extended scale. The work of manufacture and laying the main cables is undertaken by Messrs. Callender and Co., who have adopted special methods of manufacture for their heavy electric light cables, and special methods of laying the same underground. It is expected that the supply of electric current for lighting purposes in this district will be ready for the ensuing season.

Glasgow Municipal Buildings.—The Committee of Glasgow Town Council, which has charge of the electric lighting arrangements of the new municipal buildings, having opened and examined the designs of electroliers, gasaliers, and brackets which had been sent in, have selected the following: (1) Design by Messrs. B. Verity and Sons, London, per Messrs. John Finlay and Co., Glasgow, of electric pendant for the corridors, provided it is, or is made, large enough for four electric lights; the price is £13. 10s. It will be for the architect to say how many of these will be required. (2) Design by Messrs. B. Verity and Sons, London, for four gasaliers, one for each of the committee rooms; the price is £30 each. (3) Design by Messrs. B. Verity and Sons, London, for six 10-light electroliers for the salons, subject to the makers agreeing, without extra charge, to alter the design as now suggested, and the architect was instructed to see Messrs. Verity as to this—the price is £45 each; and (4) design by Messrs. Winfields, Limited, London and Birmingham, for two gasaliers with four two-light arms, one for the Lord Provost's room and one for the library—the price is £24. 10s. each.

Liverpool Central Lighting.—A most ambitious scheme, upon a scale commensurate with the importance of the town and the acknowledged advantages of the incandescent light, is now well in progress in Liverpool. The Liverpool Electric Light Company, although one of the largest and most prosperous in this country, has seldom been heard of, its policy evidently being to act much and speak little. Growing gradually from small beginnings, this company has developed into larger and larger scope, and has at last begun work upon a central station scheme for supply of the best part of the town of Liverpool. A special Act has been granted with reference to powers for taking up streets and public supply, the permission has been obtained from and plans approved by the Board of Trade and the city engineers, and the cables are rapidly being made for the installation. The district is one of the busiest parts of the town, comprising Dale-street, Water-street, Brunswick-street, Chapel-street, James-street, Victoria-street, &c., and extending to Lime-street station. The cables are being specially manufactured by Messrs. Callender and Co., 101, Leadenhall-street, with special methods of laying underground. Double mains

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will be laid on both sides of each street. The number of lights at present provided for number eight to ten thousand, but may probably be extended very shortly up to 50,000.

Aluminium.—It will have been noticed by many of our readers that Mr. Crompton, in his paper at the British Association, referred to Mr. W. J. Keep's work in America on "The Influence of Aluminium upon Cast Iron." In the current number of the *Journal* of the Franklin Institute is a paper by Messrs. Keep, Mabery, and Vorce, upon this subject, as read before the American Association for the Advancement of Science, at Cleveland. The subject is considered under twelve headings, and the whole paper will be of exceedingly great interest to all makers of cast iron, and should have a marked effect upon the requirements of aluminium alloys, and so indirectly upon the construction of large dynamos. Briefly, we may say that, by using aluminium in the casting, greater strength and solidity is obtained, and that the influence seems to be exerted in a greater degree by remelting. Another noticeable feature is, that aluminium causes the carbon to assume the graphitic form on the instant of solidifying, and, therefore, the sudden abstraction of heat does not cause chill. This effect of aluminium, therefore, is to give a uniform grain for thick and thin castings, and not allow the coldness of the mould to affect the grain. The paper concludes with the following sentence: "This hurried presentation of the remarkable effects of aluminium upon cast iron will give an idea of the great benefit which is now promised to the iron founder by the rapidly falling price of aluminium as cheapened by the electric furnace."

Search Lights for War Purposes.—The German military authorities, says *Industries*, have made some interesting experiments in night attack with the aid of the electric light. The plant used consisted of an 18 h.p. portable steam-engine, carrying a dynamo and search lamp. The novelty of the experiment consisted in using the beam of light, not direct, but as reflected from a second mirror, placed about 200 yards distant from the lamp, so that the enemy should remain in ignorance of the exact position of the electric lighting plant itself. The projector is fitted with an electro-motor, by which it may be set to any desired angle, the current being supplied by two cables from the dynamo, where the movement of the projector is controlled. Thus it becomes unnecessary to place a man close to the projector, a point which would obviously be one of great danger. The cone of light from the second projector rendered everything within a radius of 4,000 yards clearly visible. It was also found that the small quantity of diffused light in the vicinity of the lamp greatly facilitated exact aim. A party of riflemen were placed near the lamp, so that the sights of the rifles were illuminated by the diffused light, and in firing upon targets 400 yards distant, nine shots out of every ten were hits, whereas, with another party placed further back, and wholly in the dark, the shooting was far less accurate. The intensity of the light prevents the enemy from taking exact aim at the engine or any other object which is in comparative darkness.

New York Electric Light Convention.—Two important electrical conventions have just been held at New York, the first an electric light convention, and the second a telephone convention. A great deal of interesting exchange of experiences took place, and several valuable papers were read, some of which, being of general interest, we may take occasion to reproduce later on. Mayor Hewitt, of the Board of Electrical Control, stated that at first, believing electric light was a source of danger, he had investigated the matter, but found that, on the whole, they had infinitely more accidents with horses, with steam-engines, even in the building of houses, in the year than with electric light, and the results seem to show that it was positively less dangerous in proportion to any other useful agency at work in the city. A resolution was passed by the convention that they deplored the effort of rival interests to educate the public to a distrust of high potential currents, and that it was their conviction that there is no difference in the danger attending the use of continuous or alternating currents, and that both may be so transformed before being used as to render them perfectly harmless and practicable means of distributing electric power for cities. Papers were read by Mr. S. S. Wheeler on "The Overhead and Underground Wires in New York," on "Disruptive Discharges in Underground Cables," by E. G. Acheson; a description of "The Chenoweth Conduit," by A. C. Chenoweth; and a valuable paper upon the "Basis from which to Calculate the Charges for Electric Motor Service," by H. L. Lufkin. At the telephone convention several papers were read upon the "Dynamo Current Interferences with Telephone Service," and its prevention. Good must always accrue from meetings of this scientific and social character of persons in charge of installations and businesses from widely different places, and we are glad to see the meetings have been both thoroughly successful and enjoyable by the visitors.

The Rees Electric Safety Lamp.—The new safety electric lamp, invented by Mr. J. P. Rees, electrical engineer, Trinity-place, Swansea, has recently been inspected by a large number of colliery owners and managers, and others interested in the working of mines. The body of the lamp is composed of a vulcanite case measuring 5¼in. by 5in. by 3in. To the lid is attached a small brass cylinder, and on this cylinder is placed an elongated glass dome ⅛in. thick. In the vulcanite case are four cells in separate compartments, containing a supply of carbon in porous pots, which is connected with zinc in the next compartment by means of a short brass pin, with screws at each end, and placed above the surface of the diluted sulphuric acid, with which a series of cells are filled, the porous pots being filled with a liquid prepared by the inventor. Within the lid is a flat piece of indiarubber covered with paraffin wax, and which prevents the liquids from mixing together, or spilling whilst being carried. Inside a glass dome, at the top, is a bulb with an incandescent lamp, and the space between the bulb and the dome is filled with compressed air, forced from a small hand-pump through a tube, and prevented from escaping by means of a screw. This compressed air forces the bottom of the brass cylinder down, and by this device the circuit is completed. The compressed air may be left in for an indefinite time, and the circuit broken by opening the lid alone. It requires great force to break the glass dome, but should it any time be broken in the course of working, the circuit would be broken at the same time, and the light extinguished before the bulb could possibly break, so that its safety would not even then be diminished, nor can it be tampered with without being extinguished. The light given in the first instance is of 3 c.p., but by means of a number of lenses it is increased in one direction to eight times its intensity. The cost of the lamp is 30s., and it is stated that it can be maintained for ten hours at a cost of 1d.

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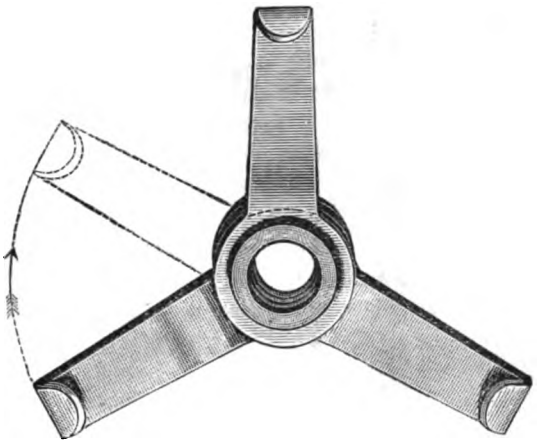
A NEW SHADE OR GLOBE HOLDER.

We illustrate herewith a new shade-holder, designed and manufactured by Messrs. Appleton, Burbey, and Williamson. Instead of gripping the shade or globe by means of screws as in the ordinary holder, the arms in this new design are movable, as shown in one instance by the dotted lines. When the arm is in the position shown by these lines, the shade or globe can be put into place, and the arm being brought back into position safely grips the globe. This



little fitting is very convenient for pendant lamps, the holder being screwed to the centre of the boss, and for electroliers and brackets it is a great improvement on the old form, as there are no screws to work loose or get lost. It is singular that so simple an idea should have waited so long before being put into a practical shape.

CORRESPONDENCE.

"FLATS" ON COMMUTATOR.

To the Editor of The Electrical Engineer.

Sir,—I shall be glad if you will allow me space to explain to "Broad Bent" that it was not my intention to put forward my idea on the cause of "flats" as final; it was merely that I had never seen this cause mentioned before, and that I cannot remember a case incurable by resoldering, out of a considerable number of machines I have tested.

As to the increased resistance of a segment causing a *greater* difference of potential, it seems to me that in the normal state each section will have the same difference. When one is higher in resistance than the others, the total E.M.F. being the same, will not there be a greater difference across the section of highest resistance? The coil will be *carrying* the current, even though inactive in producing E.M.F., except when momentarily short-circuited by the brush. In conclusion, I would say that, as a young electrician myself, I had no intention to contradict or dogmatise, but merely to offer a suggestion which I hoped might be useful.—Yours, &c.,

Derby. T. M. Winstanley Wallis.

CROMPTON'S LARGE DYNAMO.

To the Editor of The Electrical Engineer.

Sir,—I was very much interested in the paper read by Mr. Crompton before the B.A. at Bath; that part of the paper most interesting to those engaged in dynamo manufacture is no doubt where Mr. Crompton gives the details of the big machine constructed by his firm. The first thing that one notices is the very small amount of laminated iron in the armature core, the radial depth of this part of the machine being about the same as in an ordinary 30-unit machine. The enormous mass of solid metal in the centre of the armature, situated in a strong magnetic field, must be the seat of very wasteful eddy currents. Perhaps this is one of the reasons why a fan has been added to the natural cooling properties of the machine. It will also occur to most electricians that the machine being practically series wound, will largely account for the sudden fluctuations of current which were experienced, and which caused so great a strain on the arrangements provided to carry the armature conductors through the resistance of the magnetic field. None of the descriptions of the Cowles' process which I have read mention any electrolytic action of the current, the sole function of which seems to be to raise the matter under treatment to the very high temperature required. In this case one would think that an alternating would be preferable to a continuous current machine, on account of the great reduction in the first cost of the electrical plant, and the reduction of the cost of repairs, as there would be no expensive commutator to renew, &c. Perhaps there is some objection to the employment of an alternating current which at first sight does not appear; however, I venture to offer the suggestion for what it is worth.—Yours, &c. W. H. Eaves.

Coventry, September 18, 1888.

SHALLENBERGER'S ELECTRIC METER.

Some months ago a new application of the alternating current in the production of rotary motion was made known almost simultaneously by two experimenters, Nikola Tesla and Galileo Ferraris, and the subject has attracted general attention from the fact that no commutator or connection of any kind with the armature was required. The principle has been very successfully applied by Mr. Tesla in the production of a practicable motor, which is destined soon to occupy an important place among the growing number of electrical appliances depending upon alternating currents for their operation.

For some time previous to the publication of the results above referred to, Mr. O. B. Shallenberger, electrician of the Westinghouse Electric Company, had been at work on a series of experiments tending in the same direction, the results of which served as a basis for the construction of a meter depending on analogous principles, although applied in a way differing notably from anything described up to the present time by either of the investigators referred to. The meter was already completed in an experimental form at the time when the results of the experiments of Mr. Tesla and Prof. Ferraris were made known, and its thorough practicability was demonstrated, although for legal reasons it was unadvisable to make the fact known at that date.

Notwithstanding the urgent need of a meter wherever electric lighting has been carried on commercially, nothing has presented itself thus far that indicated any decided advance in this direction until the advent of the instrument invented by Prof. Forbes, the great simplicity and beauty of which cannot be gainsaid. The one apparent difficulty in the way of its adoption seems to be its extreme delicacy in the necessarily minute accuracy in its manufacture and adjustment required to obtain satisfactory results.

It has been the desire of Mr. Shallenberger to produce a meter equally simple, but, if possible, more practicable in its nature, and requiring a less degree of skill on the part of the workmen in manufacturing; or in other words, something that could be made and used in a rough and ready way without diminishing its reliability.

This, it is thought, has now been accomplished, although the use of the instrument in its present form is limited to alternating currents. In this connection it may be observed that although a few years ago one of the objections raised against the use of alternating currents was the difficulty in measuring them in a practical way, the fact is that these difficulties have gradually disappeared, until they are less important than in the use of direct currents.

The principle upon which the new meter operates may be understood from the following considerations. If an alternating current be made to traverse a coiled conductor in proximity to two other conductors closed upon themselves, the secondary currents set up in these two conductors will correspond with each other to a greater or less extent in phase, and will be approximately in the same direction at the same instant, but both will differ in phase from the primary or inducing current. An attraction consequently takes place between the two secondary circuits, and if free to move, the conductors carrying these currents will be attracted to each other in a greater or less degree depending on the amount of the primary current and on the displacement of phase between the primary and secondary currents. If one of these conductors be made fixed and the other movable, the motion will evidently be confined to one of the conductors, and if the action can be continued so as to produce the attraction always in the same direction, a continuous rotary motion may be obtained by the inductive action solely, and without any direct communication with the source of current. The discovery of this principle suggested at once the practicability of applying

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it to the operation of a meter, since it is only necessary to produce a rotary effort or torque in some simple and reliable way, bearing a definite relation to the current that produces it, in order to have a perfectly accurate means for measuring such current.

With this end in view, a number of experiments were made, which it is unnecessary to follow here, presenting a great variety of effects depending in a general way upon the principle referred to, and leading eventually to the form of meter here described.

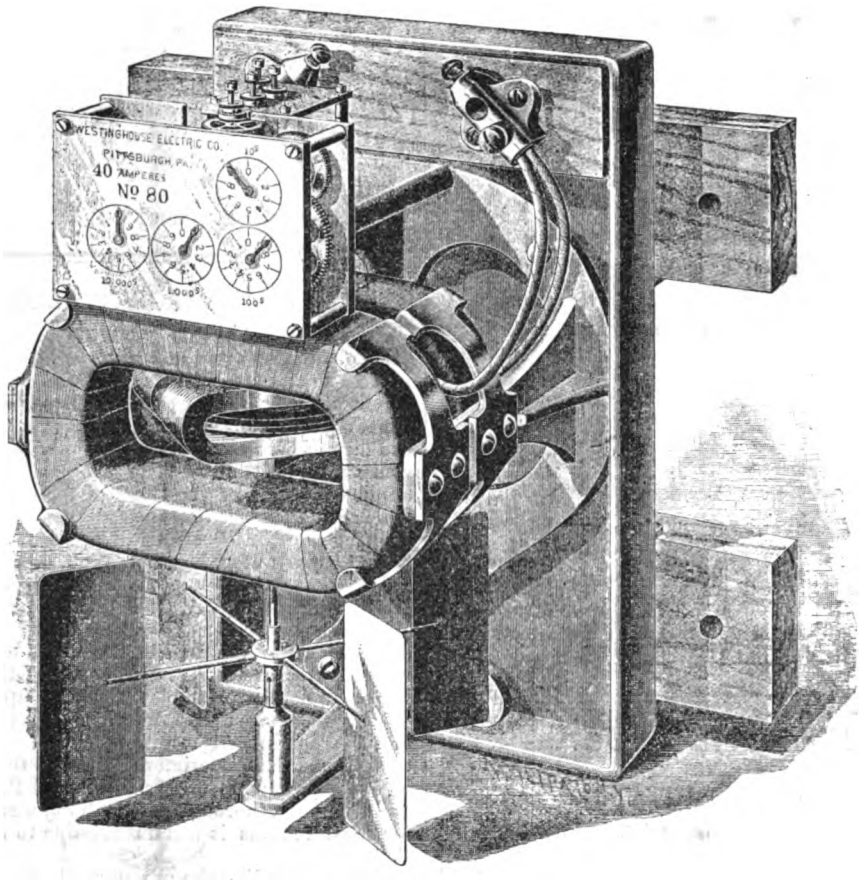

FIGURE 2.—Shallenberger's Meter (case removed).

It was found that one of the conductors might be replaced by a core of iron, inasmuch as the mutual attraction between the iron core and the coil could be made to serve in place of the attraction between the two secondary coils, and with greater effect so long as proper relations were maintained to carry out the same mode of operation. If a disc of iron be surrounded by a copper band and this with another conductor at an inclination to the first, the passage of a current through the outer coil

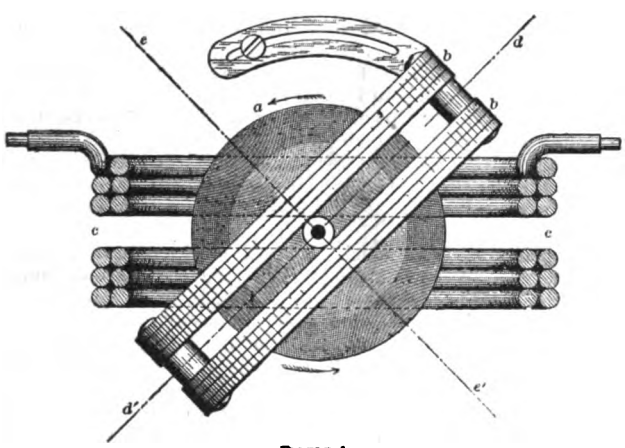

FIGURE 1.

will, by the action of the secondary currents set up in the short-circuited coil, produce a rotation of the disc; and the torque exerted is approximately proportional to the square of the current, so long as the rate of alternation is maintained approximately constant.

Referring to the diagram, figure 1 *a* is a flat ring of soft wrought iron mounted on a light disc of brass or aluminium, rigidly attached to a slender steel shaft,

b b are copper plates punched in the form of a flattened oval and riveted together at the ends, placed so as to surround the disc closely without touching it. These are adjustable in position with respect to the coil, *c c*, which surrounds the whole. When in the position shown, the rotation of the disc is in the direction of the arrows, and the torque is greatest when the plane of the coil shown by the line *d d'* is at an angle of 45deg. to that of the coil, *c c*. If while the current is passing through the coil the position of the plates, *b b*, is changed gradually to *e e'*, the speed of rotation of the disc diminishes until an angle of 90degs. is reached, and beyond this the direction of rotation reverses, reaching maximum speed again at 45deg. on the opposite side.

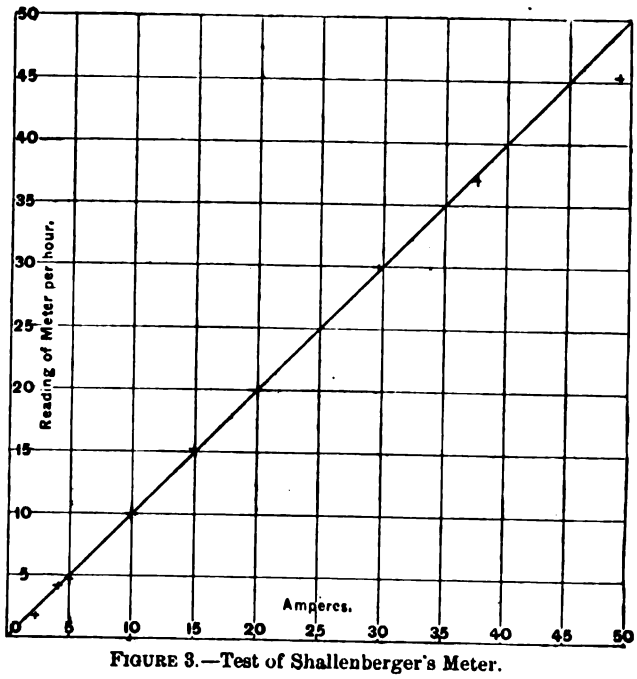

FIGURE 3.—Test of Shallenberger's Meter.

In applying this to the meter only a few degrees movement of the secondary conductors, *b b*, is required for the necessary adjustment.

This arrangement was selected from a large number of others

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because of its ease of construction, the small self-induction it introduces, and its ease of adjustment.

The maximum torque is exhibited at an angle between the coils of 45deg., while at 0deg. and 90deg. it disappears altogether. When the angle is 0deg., the coils, being parallel, have a maximum mutual induction, but no torque is exerted; and at 90deg. no current is induced in the secondary coil, and consequently there can be no torque in that position.

In order that the speed of the disc may be proportional to the current, it is necessary that some resistance be offered to its motion, which bears the same relation to the speed as that of the torque to the current, and the simplest means of doing this is to attach to the same shaft on which the disc is carried a suitable number of light vanes, whose motion is opposed by the resistance of the air as the disc revolves. This resistance is found to vary almost exactly in the proper ratio, and consequently the revolution of the disc is as nearly as possible proportional to the strength of the current. The rotations of the dics are counted by a train of wheels connected with an indicator similar to that used for gas meters, and showing ampere hours. The accuracy of the instrument is affected slightly by changes in the rate of alternation of the current; but since in practical electric lighting the rate of alternation is maintained nearly constant, the error due to this cause is quite insignificant, being less than proportional to the number of alternations. The adjustment to the exact speed required is made by changing the angle of the secondary coil; but in practice the instrument is made very nearly correct as it leaves the factory, requiring only slight correction.

TEST OF 40 AMPERE METER.

Current in amperes.	Reading of meter.	Percentage of error.
2·06	1·6	
4·02	4·08	+1·2
5·00	4·95	—1·0
9·9	10·02	+1·2
15·0	15·1	+0·7
20·0	20·0	0·0
29·7	30·0	+1·0
37·4	37·0	—1·1
	Overloaded.	
49·3	45·4	—7·9

The accompanying chart and table show the operation of a 40 ampere meter, with currents varying from the smallest capable of turning the vanes and overcoming the slight friction of the bearings, to an overload of 25 per cent. Currents are measured on the horizontal line, and the corresponding readings of the meter are shown by the vertical distances. It will be seen that the departure from the theoretical straight line representing the mean performance of the meter is very slight, and in no case within the working limits reaches 2 per cent., except at starting point; while at 25 per cent. overload, the proportional rate only falls off 7·9 per cent.

The ease with which this meter may be adapted to circuits of different capacity is obvious. By interposing between the meter and the circuit to be measured a small converter, the current may be reduced or increased in any ratio, and since the energy transformed by such converter is only the amount required in operating the meter, namely, about one-eighth of one per cent. of the energy measured, the dimensions of the converter may be very small, and consequently but very little is added to the cost of the simple meter. By changing the ratio of this converter any capacity may be given to the meter, so that the same instrument may be used to measure ten lights or 10,000 lights within the same percentage of accuracy, and without change in its onstruction.

There is, however, one feature worthy of notice in this connection, namely, the point at which the meter will begin to turn, or, in other words, the percentage of its full load at which the registering of the current begins. This, in the 40 ampere meter already mentioned, is 1½ amperes, or say three per cent. of the rated capacity. While this represents only one or two lamps on a 40 ampere meter, and only one lamp on a 20 ampere meter, it will be seen at once that on a meter for 1,000 lamps the same proportion would give 30 lights required to start the counter.

In order to overcome this difficulty for the larger sizes of meters a shunt coil is provided, which, with a current almost inappreciable in amount, charges the inducing coil of the meter to a degree sufficiently barely to overcome the inertia and friction of the vanes, and in this way the large meter may be made to start on less than one per cent. of its full load as easily as the small meters start on three per cent.

There are certain cases in which it is very desirable, even where a large number of lights are installed, to measure a comparatively small proportion of the total current. Lamps are sometimes used for watch lights and other purposes, while the main body of the lamps are or are not in operation, and it is for this reason that the shunt coil is applied. Its operation may be made as sensitive as the conditions require.

The greater simplicity of the meter having a direct coil only, both in its construction and connection in the circuits, makes it preferable not to employ the shunt coil on any of the smaller sizes—namely, below 40 amperes. But it is evident that in special cases where it is desired to measure accurately the widest possible range of current the shunt coil can be employed with advantage.

Practical tests have shown this meter to be thoroughly reliable in its action, and with the exception of some minor details in the construction, no serious difficulties have presented themselves at any time. The meter as now manufactured for practical use seems to fill the requirements very satisfactorily, and has given no cause to doubt its entire reliability within limits of error much smaller than have hitherto been obtained in ammeters, voltmeters, and similar instruments.—*New York Electrical Engineer.*

ELECTRIC LIGHT APPLIED TO NIGHT NAVIGATION UPON THE SUEZ CANAL.*

BY R. PERCY SELLON.

I.—The period embracing the concluding years of the last decade, and the first years of the present one, during which a grave commercial crisis made itself felt not only in this country, but throughout industrial Europe, witnessed upon the great maritime highway which separates the eastern and western hemispheres a rapid increase of traffic and growth of activity.

In 1870, the year following the opening of the Suez Canal, 496 vessels of all kinds availed themselves of the facilities which this new highway to the East afforded. Two years subsequently—in 1872—this number had reached over 1,000. In 1878 the number was 1,593, and by the year 1885 it had more than doubled itself, reaching the remarkable total of 3,624 vessels, representing a gross tonnage of 9,000,000 tons.

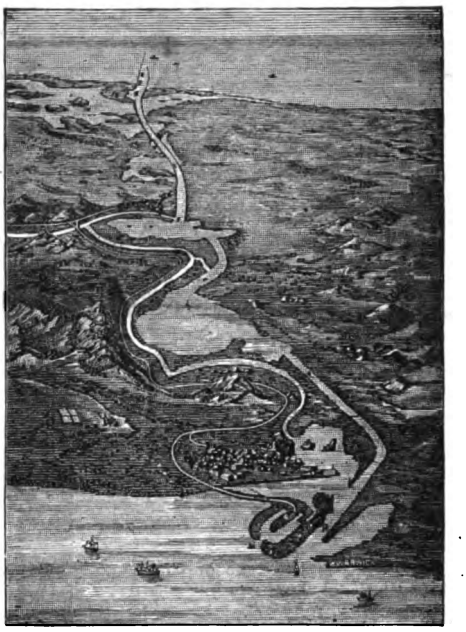

FIG. 1.

This active traffic, however, soon gave rise to difficulties of various kinds. Shipowners complained of delays in making the passage of the canal, delays which became more and more marked as the number of vessels using the canal increased. The channel proper being insufficiently wide (except at the "tying up" stations, which are placed every five miles apart) to admit of vessels passing one another, it becomes necessary for any vessel to "tie up" in accordance with signals from the nearest station—these stations being all in telegraphic communication with one another—while any vessel coming from the opposite direction gets past.

This in a canal 87 geographical miles long, and where the speed (except in the open Bitter Lakes) is not allowed to exceed six miles an hour, means constant delays at "tying-up" stations, the delays naturally increasing directly in proportion with the traffic.

Then a further cause of delay lay in the fact that vessels could only proceed by day, anchoring at either entrance to the canal—Port Said or Suez—or "tying-up" at the nearest station, if in mid-channel, from sunset to sunrise. Thus we find that in 1885 the average time consumed in making the passage of the canal amounted to 43 hours, though it frequently considerably exceeded this.

II.—To meet the difficulty thus presented, the Suez Canal Company set about various improvements; the cutting away of curves in the course, deepening and widening the channel at the tying-up stations, and finally instituted experiments to determine the practicability of navigation by night by means of the electric light.

The question of the practicability of successful navigation by night in the Suez Canal by means of electric light is not so simple as it would at first sight appear. To realise this, one must consider that the canal has but an average width of 22 metres (23¼ yards) upon the water line,

* Paper read before the British Association, at Bath.

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with shelving sides, providing for a depth of water of some 8m. 70 to 9 metres (27—30ft.) in the centre, and with comparatively sharp curves at various points, as may seen from the accompanying plan of the canal; and that under such conditions vessels of 400ft. to 500ft. length, 40ft. to 50ft. beam, and drawing 25ft. of water, have to navigate the channel, encountering currents of varying force, the action of the wind, and greatly diminished influence of the rudder upon the vessel owing to the slackened speed.

It will be seen at once that under these circumstances it needs but a small deflection between the axis of the vessel and that of the channel to render the vessel liable to run aground. No small amount of judgment and experience thus becomes necessary on the part of the pilot who accompanies each vessel through the canal. The problem was, to reproduce by electric light the conditions requisite to enable the pilot to successfully navigate during the night.

These experiments extended over the greater part of two years, with the result that in December of 1885 it was decided to allow vessels of war and those carrying mails, if furnished with electric lights in accordance with regulations laid down by the canal company, to proceed by night between Port Said, the Mediterranean entrance to the canal, and kilometre 54, about one-third of the distance along the canal.

The first vessel to avail itself of this permission was the ss. "Carthage," of the Peninsular and Oriental Steam Navigation Company, in the month of April, 1886, followed shortly afterwards by others, the prescribed passage being made by night by means of the electric light with perfect success.

These and subsequent trials encouraged the Canal Company to extend its authorisation to vessels of all kinds; and, at the same time, by providing beacons and light buoys to guide the vessels in their course by night, to permit of navigation throughout the whole length of the canal.

factured, as are also the electric lamps and other electrical apparatus, by the Anglo-American Brush Electric Light Corporation, Limited, of London. The engine and dynamo are fitted upon a cast-iron bedplate common to both. To ensure reliability of operation, and minimise labour in attendance, the speed of engine and dynamo is reduced to 600 revolutions per minute, at which speed the latter is capable of yielding an output of 65 volts × 70 amperes of 4,550 watts. This provides for a light in the projector search light equal to 12,000 c.p., and at the same time supplies current for the automatic lamp of 6,000 c.p. over the bridge, when this latter is in use.

The projector search light, fitted upon its platform and fixed during the passage through the canal to the stem of the vessel as near to the water's edge as possible, as shown in the accompanying diagram, is used to light the course of the vessel to a distance of 1,200 metres (1,300) yards ahead.

Actually, the firm of contractors above mentioned have heard, from recent advices from the canal, that this light enables the pilot to see clearly as far as 1,600 yards ahead.

The projector proper, which is in many respects similar to the type in use for signalling and search purposes on war vessels, consists of an electric lamp of 12,000 c.p., the light rays from which are concentrated upon a spherical silvered mirror, made by Messrs. Chance, of Birmingham, fixed at the back of the instrument; this mirror reflects the rays, rendering them parallel, and projects them forward in a cylindrical beam; they are then made to pass through a series of plano-cylindrical lenses fitted in the front of the projector, so that the beam emerges in the shape of a fan, flattened horizontally.

This beam, diverging to an angle of 20deg., can by means of suitable adjustments provided for the purpose be directed upon any desired spot. At a distance of 1,200 metres ahead of the vessel the full width of the canal and the banks on either side, composed of the *débris* excavated from the channel, are illuminated as clearly as by day.

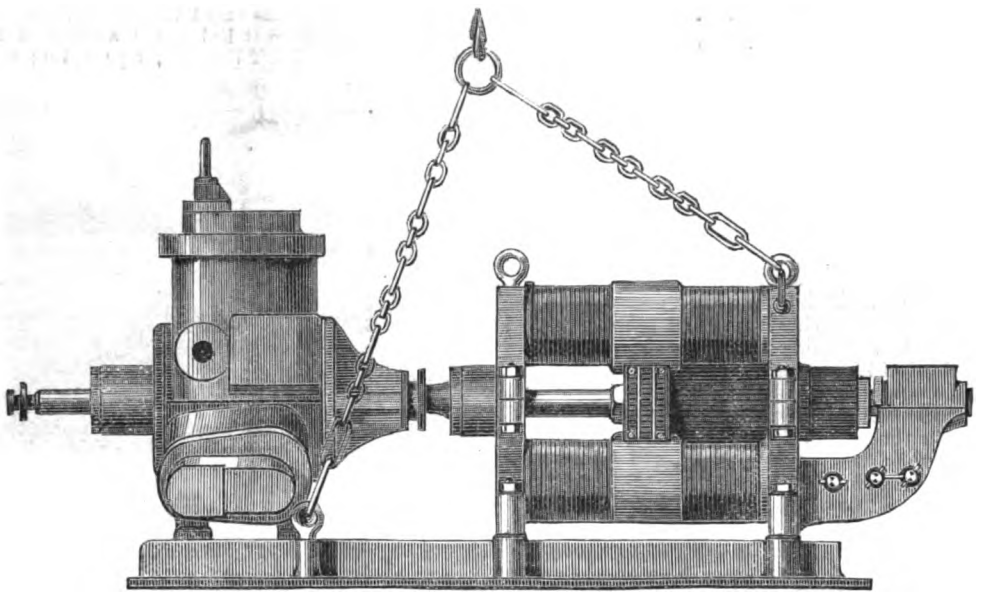

FIG. 2.

III.—The following is the text of the regulations on this subject issued by the Suez Canal Company in February, 1887:

"(i.) From 1st May, 1887, steamers will be allowed to pass through the canal by night, subject to the same conditions as those which hold for navigation by day, and subject to the following further restrictions:

"(ii.) Steamers intending to pass through the canal by night must satisfy the company's agents at Port Said or Port Tewfik, that they are provided: (1) Forward, with an electric search light throwing a beam 1,200 metres; this search light must be placed as close as possible to the water line. (2) With an electric lamp and a reflector suspended above the bridge and capable of lighting a circular area of about 200 metres diameter.

"The agents of the company will decide whether the apparatus fulfils the requirements of the regulations, so that vessels provided with them may without inconvenience be authorised to navigate the canal by night.

"(iii.) If a vessel proceeding by night receives the signals to 'tie up,' it must, immediately upon this being effected, extinguish its electric lamps, retaining only the regulation signal lights indicating that it is 'tied up.'"

IV.—Passing now to describe the apparatus designed to fulfil these requirements. This consists essentially of three parts:

(1) The source of electric power—a steam-engine and dynamo-electro generator.

(2) A projector search light fitted upon a platform large enough to accommodate a man to manipulate the light: the whole being attached to the stem of the vessel forward and close to the water's edge.

(3) An automatic electric lamp suspended above the bridge and capable of illuminating a circular area of 200 yards diameter round the vessel.

The accompanying diagrams illustrate the various pieces of apparatus, and also a vessel so fitted traversing the canal.

The engine is of Brotherhood's 3-cylinder type, fitted direct by means of a flexible coupling to a Victoria dynamo-electro machine, manu-

An attendant, seated upon the platform, attends to the manipulation of the carbons of the electric lamp, and at the same time regulates the position of the beam of light, elevating, depressing, or deflecting it on either side in accordance with the orders of the pilot upon the bridge, with whom he is generally in telephonic communication.

The placing of the projector close down to the water's edge, where the light is hidden under the bow of the ship, is a point of essential importance, since any direct rays of light intervening between the pilot and the distant object illuminated by which he steers the vessel, serves to dazzle his eye.

The automatic electric lamp is of 6,000 c.p., enclosed within a lantern, and fitted with a concave reflector, arranged to concentrate the light round a circular area of 200 yards. In this way the area illuminated comprises the whole deck of the vessel and the canal and its banks immediately on either side. This light is only intended for use when passing other vessels "tied up" at the stations, or to provide light around the ship when "tying up" so as to allow another vessel to pass.

V.—A large majority of mail and passenger steamers are now fitted throughout with the incandescent electric light. In fact, electric light has come to be regarded as a *sine qua non* to any first-class passenger vessel.

In such cases, the steam-engines and dynamo generators already in the ship are usually utilised to supply electricity for the special Suez Canal lamps, which latter may form part of the permanent equipment of the vessel. This is the case with many of the vessels of the P. and O., the Orient, and the North German Lloyd lines of steamers. On the other hand, where a vessel which is not already fitted with the electric light desires to avail itself of the permission to traverse the canal by night, it can hire the necessary plant at either entrance to the canal.

The *modus operandi* is as follows:

Several of the prominent coaling firms at Port Said have possessed themselves of a certain number of sets of portable electric lighting

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plant for the Suez Canal. These they hold in readiness for vessels to their consignment who may require the light, making an average charge for the use of this, which at the present time amounts to £10 per vessel for the passage through the canal.

On receiving a given signal from an incoming vessel that electric light is required, a tender is sent out to meet it, having on board the necessary portable plant. Coming alongside, the engine and dynamo are quickly hauled up, dropped on to some convenient spot on deck, and the engine connected with the nearest convenient steam-pipe—generally one belonging to the system in use for steam-winches forward; the automatic lamp slung up over the bridge; the projector floated round and made fast to the stem; temporary conducting wires run from the dynamo generator to the two lamps; and in less than an hour from the time of the tender coming alongside, the ship is ready to make the passage of the canal by night. On reaching the opposite end of the canal the electric light plant is disembarked, and the vessel proceeds on her way.

It is with such a portable plant as has just been described, and which the accompanying diagrams illustrate, that the author was engaged in trials upon the Suez Canal in the early part of last year.

VI.—To realise the development which has followed upon the introduction of electric light for the purpose of night navigation, and to appreciate how real has been the benefit flowing therefrom, we have only to examine the following figures, which illustrate the number of

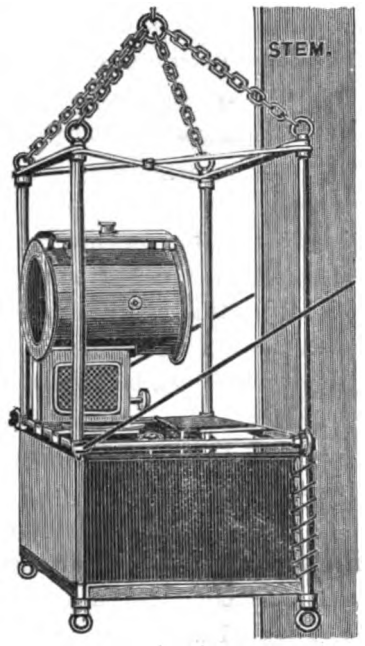

FIG. 3.

vessels which have passed through the canal in this way at different periods since the first authorisation to use electric light in December, 1885, and which define the percentage of vessels so using the light in comparison with the whole traffic on the canal:

PERIOD.	Number of Vessels which passed through the Canal by Night by means of Electric Light.	Percentage of these to the whole Traffic.
From December, 1885, to 1st March, 1887—viz., 15 months	25	70 per cent.
March ,,	15	
April ,,	19	
May ,,	19	7½ ,,
June ,,	25	
July ,,	27	
August ,,	35	
September ,,	45	
October ,,	49	18 ,,
November ,,	62	
December ,,	75	
January, 1888	85	29 ,,
March ,,	111	34½ ,,
May ,,	139	43 ,,

VII.—It remains but to enquire "What are the advantages arising out of the use of electric light on the canal, which have led to so striking and rapid a development?"

To the Suez Canal Company, on the one hand, it means that the capacity of their canal has been rapidly, effectively and economically increased by nearly 50 per cent., an increase attained without an army of labourers, without a host of dredgers, without a lapse of years, without interruption to traffic; that while a traffic which reaches 7,000,000 to 8,000,000 tons is now actually attained, an increased traffic, equal to 11,000,000 to 12,000,000 tons per annum can be accommodated, while offering not only equal, but greater, facilities to shipowners making use of the canal; that in the meantime the canal company, relieved of the pressure put upon them from outside, can pursue their works of improvement with greater deliberation and economy.

It is only fair to say, however, that the Suez Canal Company on their side have displayed a ready initiative and far-seeing confidence in the success of the scheme, by putting down a large number of light-buoys to indicate the course by night in the Bitter Lakes, of guiding lights along the banks, and an extensive gas works at Ismailia for supplying the above with gas at a time when to many an extended adoption of the electric light by shipowners seemed problematical. To shipowners, on the other hand, it means in the first place a saving of time. I pick up the *Official Gazette* of the Suez Canal Company, published at Paris, for January of this year, and read as follows: "The 'Moskwa,' of the Russian mercantile marine, using the electric light, entered the Suez Canal on 12th December at 6.15 p.m., and passed out on the following morning at 8.45 a.m.; total time occupied in the passage 14½ hours."

In another portion of the same *Gazette* for the same month I read as follows: "The mean time occupied in making the passage of the canal for all vessels during the month of November last was thirty-six hours ten minutes."

Taking as average periods for the passage of the canal, eighteen to twenty hours for all vessels using electric light, and thirty-five to forty hours for all vessels not so provided—figures which the canal company's official *Gazettes* and the author's own experience upon the canal prove to be in accordance with actual facts—we find that the saving of time resulting from the use of the electric light approaches the twenty-four hours of a whole day. What does this saving in time represent?

For vessels carrying cargo exclusively, of an average tonnage of, say, 2,500 tons, interest on capital, demurrage, coal consumption, wages, and provision for the crew represent a sum of £30 to £40 per diem

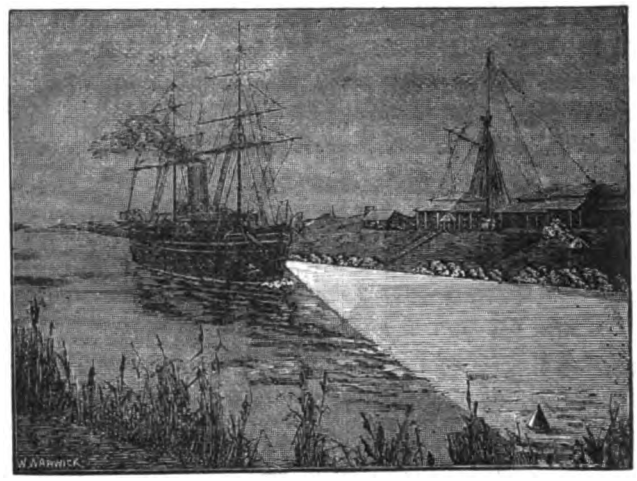

FIG. 4.

For vessels of war, where rapid communication between England and her possessions in the eastern hemisphere, or the scene of her frequent wars in the Soudan or Africa is by way of the Suez Canal, the saving of 24 hours may entail consequences not easy to calculate.

For mail and passenger boats the results are naturally more marked than in the case of cargo steamers.

An interesting example of the practical value of the electric light is afforded in connection with the transport of mails to the East during the time when the cholera in Italy led to enforced quarantine of all vessels from Italian waters communicating with the shore in Egypt. It has been customary for the mails brought by the Peninsular and Oriental Company from Brindisi to be landed at Alexandria and sent overland to Suez to save the time taken by vessels in the canal. In order to avoid the delay of quarantine, the mail boats of the Peninsular and Oriental Company proceeded, without unshipping the mails, direct through the Suez Canal by means of the electric light, reaching Suez and transhipping the mails within the same time as that occupied by the overland route in the ordinary way.

The cost per 24 hours of a first-class vessel of this kind, including insurance, demurrage, interest on capital, coal, wages, provision for the crew, and provision for the passengers, cannot be put down at less than £100 to £150.

Taking as an average saving effected by each vessel traversing the canal by night, a sum of £70 to £80, a figure which, in view of the proportion of mail and first-class passenger-carrying vessels to the whole traffic on the canal is well within the mark; and taking 40 per cent. of the vessels entering the canal as making use of the electric light, a percentage which it will be borne in mind has already been exceeded; we find that for 1,200 vessels having so availed themselves of the electric light, the annual saving to maritime commerce will amount at a minimum valuation to close upon £100,000.

And to this must be added the personal comfort to all concerned derived in escaping some period of the excessive heat experienced upon the canal by day, the glare from the banks of yellow-white sand, the tedium and monotony of the slow passage through a wide expanse of barren desert.

In conclusion, without considering to what development this use of the electric light may ultimately attain in an age in which increasing efforts are being made to economise time and space, it has been attempted, by the foregoing few facts and figures, to illustrate the advance recently made in one adaptation of electricity to the service of man.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

LIGHTNING CONDUCTORS.

Perhaps the most entertaining part of the late British Association meeting at Bath was during the discussion on Lightning Conductors on Tuesday morning, Sept. 11, in section A. The discussion partook of the nature of a pitched battle between sections A and G: the champion of section G being its president, genial Mr. Preece, who was opposed from section A by Prof. O. J. Lodge. The latter gentleman, in his lectures before the Society of Arts in the early part of the year, had put forward views derived from the results of experiments that were somewhat startling, and it was these views that were in dispute. Mr. Preece, Mr. Symonds, and others did not agree with them, and it was thought the British Association meeting would present an admirable opportunity for both parties to put forward their views, and attempt to reconcile their differences. The popularity of the speakers and the interest in the subject was evident from the crowded state of the meeting. The result (as will be seen from the full report—a portion only being given in this week's issue) might be termed a drawn battle, both sides having scored some points, the general idea being that Prof. Lodge had fairly held his ground but had not routed his antagonist. Several points were, so to speak, reserved for written communications to the press, and some were not touched upon at all. One of these latter it may be well to call attention to here. Before Snow Harris commenced protective operations on the Royal Navy, the damage done by lightning was known to be considerable, and we venture to think the comparison between the damage done in a similar manner since protection had been effected, would have been both instructive and interesting. Has there been one single proved case of the loss of a vessel since because of lightning stroke? No doubt vessels leave port and are never again heard of, and it may be the total loss is due to lightning stroke, but of this we know nothing and can know nothing. The disaster is more likely to be due to the bursting of a boiler. However, no point was made by either party as to the effectiveness or the ineffectiveness of the method of protection adopted on board ship. Come we then more directly to the question under discussion, the protection of buildings on land. Mr. Preece contended that whenever an accident happened it was easily traceable to negligence, some part of the apparatus was defective, or erected in a manner contrary to that suggested by the report of the Lightning-Rod Conference. In this report the best experience of the age is to be found, and if its rules are followed there will be, maintained Mr. Preece, absolute safety. Prof. Lodge, on his part, referred to Melsen's work at the Hotel de Ville at Brussels as having been looked upon as the most

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perfectly protected building in the world, yet an accident had happened at Brussels, though the details were not generally known. It should be pointed out that Prof. Lodge's suggestions as to house protection are but modifications of those of Clerk-Maxwell's cage system. We incline to the opinion that a house protected by flat chimney plates at the top of the chimney, armed around the edges with barbed wire, and connected to barbed wire protectors along the ridges and eaves, continued by a number of galvanised iron wires down the sides of the house to good earth, would be more effectually protected than by the single lightning rod which is but too frequently used.

We have already given Prof. Lodge's lectures and some slight comments thereon, so that it is not necessary to traverse the ground again. One of the most important points in Prof. Lodge's experience brings into question what may be termed the time function, and we must confess at present to being in a state of doubt as to the accuracy of any deductions which may be drawn about the value of iron *versus* copper. Advanced electricians can understand the argument of Prof. Lodge, but engineers and architects may prefer analogy. A heavy blow given to water in a pipe will most probably fracture the pipe and the water will escape where it is not wanted, is perhaps nearly analogous to what Dr. Lodge means when he speaks of the lightning stroke, instead of being carried safely to the ground by the conductor, going off by a side flash and meandering around to some distant pipe or water-butt. If instead of a blow, a steady pressure be applied to the water, such pressure will be duly transmitted, and so, no doubt, in the case of electricity, when the current will be duly conducted. But why the copper, in Dr. Lodge's experiments, should have acted more unfavourably than iron is not clear. The opposite might have been expected. Nor are we much helped by the suggestion that it is not so much sectional area as surface action which has to be considered. One point, we think, Mr. Preece carried without doubt, that the lightning flash could not be considered oscillatory because the discharge of a Leyden jar was oscillatory in its action. The most important practical outcome of the discussion is whether we can in any way cheapen the protection of buildings from lightning by adopting Prof. Lodge's suggestions, provided the conclusions of competent authorities are that the system is safe. It was laughingly stated that the safest building would be one constructed wholly of iron, without openings—other, we presume, than a descent by steps to an entrance effected under the floor. This is carrying the cage system to extremes, and is not practicable. While it is cheaper to insure rather than protect, protection will be the exception and not the rule. Otherwise it would pay the insurance companies to carry out a system of protection for themselves. The weak point in the present system is this possibility of a side flash, and though whenever it occurs it is said to be due to negligence, it does occur, and occurs in places which were supposed to be perfect. What the continued controversy through the medium of the press will bring forth is unknown, but it will be carefully followed, as is every scientific discussion which has so visible and immediate a connection with the saving of money, property, and life.

INCREASING ACTIVITY.

The passing of the amended Electric Lighting Act seems to be not without avail. Increased activity is arising on every hand, and this season bids fair to be one of the most important in the development of the electric lighting industry in Great Britain. We chronicle this week the start that is to be made in taking up the streets at Whitehall early next week for laying the electric supply mains in that district. The Kensington Company is also extending its mains into the great residential district of Knightsbridge. Both of these stations are on the battery-transformer low-tension system. The London Electric Supply Company are rapidly pushing forward the work at Deptford, which is to supply 500,000 lights eventually, to the City and West End, on the alternate-current-transformer high-tension system. In Liverpool—our next largest English town—great activity is being shown by the Electric Supply Company, who have completed arrangements for extended supply of a large number of lamps to the most populous district of Liverpool, and the work is now in hand. Bradford, Brighton, Hastings and Eastbourne are extending their existing supply. Besides this, Barnet and Buckingham have central stations in progress. Bath is being fitted, Chatham and Gravesend have work in hand; while Dublin, Cheltenham, Exeter, Dover and Folkestone, Swansea, Richmond, Norwich, Poole, North Shields, Otley, and Fleetwood—to mention a few names of those who have lately inquired for or invited tenders—amongst numerous other towns, have been stirred with the desire to possess themselves of the benefits of this, the greatest and most beneficial of the latter discoveries of science. While in America there is hardly a town of 5,000 inhabitants that does not boast its central station, nor scarcely one of 10,000 that has not, at the present time, an electric railway in debate, if not in operation or course of construction, we, in England, have continually been feeling ourselves somewhat left behind in the use of our own inventions and perfections. At last, however, the air clears, and activity begins to show itself all round. We are at

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least—we may congratulate ourselves—never likely to have to put up with the hideous mixture of posts, poles and wires of all descriptions, hanging in festoons to the imminent danger of the public, too often heard of in America, nor to disfigure our urban streets with innumerable poles; but with the inauguration of the finest systems of underground distribution science can now afford us for our light and our power, and with electric accumulator cars for our tramway service, now, we hope, happily to extend in every direction, we shall not fail to reap in beauty and convenience the reward of our period of waiting for the electric light.

ELECTRIC LIGHTING IN AMERICA.*

BY PROF. GEORGE FORBES, F.R.S.

Having since the last meeting of the British Association had occasion to pay two visits to the United States, and while there to study very carefully the systems of central station lighting in vogue, and also to compare what was being done there with what was being done here, and being, further, able to compare the state of central station lighting in America as it is at present with the condition it was in four years ago, when this association visited America, I felt it was a sort of duty I owed to the association to bring before it some account of what I had seen, believing it would be especially interesting at the present moment, when there are signs of a very great determination on the part of the public in this country to have electric light supplied to them from central stations. At the same time I felt considerable diffidence in bringing before you the facts which have been collected—not in the least because there is any want of facts, but by reason of their number, which renders it difficult to make a proper selection of the points likely to be of interest to the members of this section and to electric lighting engineers.

In the first place, remark has been often made to the enormous progress which central station lighting is making in America. At the moment one lands one is struck by it; and when one lands, upon returning to England, one is equally struck by the dimness of the lighting in our country. In America there is not a single town with which I am acquainted where you can walk in the streets at night without seeing an abundance of arc lamps. I am not simply speaking of the principal towns, like New York, Philadelphia and Boston, but of the most out-of-the-way places in the most distant States, where gas has never penetrated. There electric lighting has fixed its position, and it is being used frequently. Not only has the electric light been adopted in these remote towns, but other developments of electricity have followed. As an illustration of the kind of places to which electricity and electric light have found their way, I may mention that I have a paper here published in a village in Alaska, one of the least developed of the territories of the United States, and the same number of this paper, which treats of the introduction of electric lighting in a scientific manner, treats also of the advisability of passing a law to expel Indians from the city at nine o'clock every evening.

At the time I was attending the Electric Light Convention at Pittsburg last February, it was estimated that there were 300,000 arc lamps lighted from central stations in America. The progress of arc lighting of late years, however, has not been so striking to an Englishman as formerly; the arc light was firmly established when the British Association visited America four years ago. The progress which has struck us most of late has been the progress in incandescent lighting from central stations. At the same time—I am speaking of February of the present year—it was estimated that there were 2¼ millions of incandescent lamps in use in the United States; and the rate of manufacture has increased enormously, to my knowledge, since that short time ago. There are four or five manufacturing places in the United States at this moment, each capable of turning out 10,000 incandescent lamps every day, and I have no doubt that the annual rate of production now is to be counted by millions. Of incandescent central stations there are two classes, those upon the three-wire system, in which a continuous current is supplied to the main conductors over a town and the lamps are connected by branches to the system of positive, negative, and intermediate mains. That is the system which is so largely adopted in all the Edison stations; it was the Edison stations which interested us most in 1884, and they have continued to advance and have developed the three-wire system to a very great extent indeed.

But I feel quite sure that the greatest progress that has been made in central station lighting in America since the association visited it, has been by the work done by Mr. Westinghouse in that country. One of Mr. Westinghouse's agents in passing through Europe saw the experiments which had been made by Messrs. Gaulard and Gibbs in this country on the use of alternating currents to distribute the electric light. By means of this system an alternating current of very high tension could be passed along the streets over conductors of very thin diameter and very cheap to construct, and at the consumer's premises this high tension dangerous current could be reduced in tension by means of an induction apparatus called a converter, and passed into the house at a harmless pressure suitable for the ordinary incandescent lamps.

And here I may say that I never fail to take any opportunity which presents itself to me to say what I feel with regard to the energy and determination with which Messrs. Gaulard and Gibbs, in spite of the most adverse criticism which was universally passed upon their first attempts, persevered and continued to improve their invention, and eventually proved to the world that it was possible to have a commercial system of lighting by means of these converters.

Mr. Westinghouse, on seeing this system, took it up, and the result is that he has established, in the course of a very few years, an enormous business in central station work. It is now a possibility in America—not a possibility merely, but a thing of daily occurrence—for a town to write an order for a central station, which has to be sent out at ten days' notice. They do not order a dynamo, set of conductors, and other apparatus all independently, but complete central stations are being sent out from Mr. Westinghouse's works. In December of last year the manufacturers of incandescent lamps drew out a long list of the number of lamps being used in different parts of the country, and I have abstracted from that list some notes which show that at that time Mr. Westinghouse's alternating current system was supplying 153,285 lamps, occupying 152 distinct plants, and 42 of these had plant for more than 1,000 lamps. At the present moment they have set up 110 central stations with 191,000 lamps.

It has been said that in this country we do not go ahead so much as they do in America, and various reasons have been suggested to account for this. Prof. Ayrton's most admirable reason seems to go a long way—namely, that there are two definitions of inertia: the English, which is that inertia is a resistance to motion, and the American, that it is a resistance to stopping. But I must say that in electric lighting we certainly have been stopped a great deal by what I might almost call the iniquitous Electric Lighting Act. And I regret extremely, in the interest of the public and of electric lighting generally, that an Act has been passed this year which has not yet put electricity on the same footing as gas. This is a matter for extreme regret to all those who have the ultimate benefit of the electric lighting industry at heart, for that Act will delay the due recognition of the value of electric lighting.

But I must say that I do not think the Electric Lighting Act is the only thing which has delayed our progress, because I see that in electric traction and other developments of electricity also the Americans have gone ahead with great energy, and I certainly do not put it down to want of capacity on the part of our inventors, for I find that the best dynamo machines as well as arc lamps were all designed originally in England. But, with inferior machines and lamps in the States, I have noticed that they are determined, as long as they have something which they know will work, to make it work well, and be ready in the meanwhile to take up something else. I think, therefore, that is not in the inventors that we have to look for go-aheadness, but to men of capital who are also technically instructed. I think it is technical instruction among the moneyed classes that has developed electrical engineering so much in America of late years.

I will now try to describe some of the leading features of the Westinghouse central stations which I visited, and perhaps this may be of use in helping us to draw some conclusions as to the lines in which we are to develop electric lighting in our own country. I do not in the least wish to say that the American arrangements are the best. In many points I see objections, and many where I should wish to see improvements; but we have in the system which I am going to describe a thoroughly successful working arrangement, and although we in this country may not adopt all the points of such an arrangement, still I feel that it will be of use to us to realise what is being done on the other side. It is a curious thing, for example, that in America there is hardly any work being done with accumulators. There is an example where we have led the way, as compared with the Americans. I was struck with the fact in 1884, and still more in the present year, that accumulators do not seem to work in the American atmosphere; at any rate, people have been importing numbers of accumulators, and yet they are not recognised as the generally satisfactory apparatus we have come to regard them; they are looked upon there as being as uncertain now as they were with us four or five years ago.

The Westinghouse system, then, chiefly depends upon the apparatus which has been called by the names secondary generator, transformer, or converter; "converter" is the term generally adopted in America. This is simply an induction apparatus with two coils, a primary and a secondary. The primary coil, in contradistinction to the ordinary Ruhmkorff induction coil that we have known so long, is of high resistance, with a large number of turns on the primary and a small number on the secondary, which goes to the lamps. The alternating current produces induction in passing through the primary, which reacts on the secondary, thereby producing a current of low tension going into the houses. The primary coil and the secondary are completely separated, and when properly constructed it is quite impossible that the high tension current can ever reach the secondary circuit, so that the consumers of electricity have nothing to fear from the dangerous current which is distributed from the central station.

A central station contains furnaces and boilers, engines, alternate current dynamos, exciting dynamos, switch-boards, testing instruments, repairing shop and stores. The scheme of arrangement of the mechanical and electrical parts is generally the same in every station.

The wires led out from the station are carried generally on poles as feeders to the separate districts. The secondary wires inside the house, to which the lamps are attached, are laid in the usual manner, and are connected to the secondary poles of the converter. The dynamos are run day and night without cessation; charges are made by contract or by meter.

* Paper read before the British Association at Bath.

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We hear a great deal of the imposibility of running machinery day and night without breakdowns, and I cannot help rather endorsing the opinion I heard universally expressed in America—that this fear has been enormously exaggerated in this country. When we see our huge 10,000 to 15,000 h.p. engines traversing the ocean, performing their work for days and weeks without breakdown of any sort, it seems absurd to expect that where we are able to subdivide our power, as in a central station, there should be any serious breakdown in a properly organised system. As a matter of fact, I assure you that in America central stations have been running (without accumulators) for years and years, and it is a matter of the utmost rarity for an accident to arise of sufficient importance to stop the general lighting of the district. The Edison central station in Pearl-street, New York, which has been running many years, has, I believe, only once broken down, and that was an accidental occurrence due to too much current being turned on on a foggy day, and the experience of other central stations is to the same effect. The general view in America is that there is no danger of a breakdown ever happening in a properly organised station.

It happens that in the department of furnaces and boilers there is much of special interest in many of the Westinghouse stations. This arises from the fact that over a great part of Western Pennsylvania the fuel employed is the natural gas obtained from the wells in that region, and carried in pipes to considerable distances. But this is a feature so peculiar to the district that it requires only a short notice here. I may, mention, however, that I was surprised to hear Mr. Dowson say that he did not expect to see his gas used for the boilers of steam-engines. In Pittsburg they use gas as fuel in preference to coal.

The gas with its due proportion of air to produce the high temperature of a Bunsen burner, is admitted by pipes with a sufficient number of nozzles into a combustion chamber. Here the burning gas passed over a mass of bricks with ventilating spaces, and thence through the tubes of the boilers. The gas is nearly free from carbon, and the hydrogen, which is paramount, undoubtedly weakens the iron of the boilers; but practice shows that this action does not go far, and the iron acquires a final condition in which it does not deteriorate, but seems capable of indefinite use.

In the best stations the admission of gas and air to the furnaces is regulated by means of a valve controlled by a lever, which in its turn is subject to the pressure of the steam in the boiler. This automatic regulation is very perfect, so that the attendance of one man to the boilers and furnaces of a station with several thousand horse-power is quite sufficient.

As to steam-engines there is no need to say much, for I do not think the Americans can teach us anything about making steam-engines. But there are some points in connection with the class of steam-engine used which I think are of importance. The desirability of introducing large, powerful, slow-running engines which are economical in the consumption of coal into central stations has often been talked of. Practical experience, however, has decided the question for the present exactly in the opposite manner. It is found to be more economical and safer to have a number of dynamos in each station, each driven by a separate engine of high speed, the power in America being always transmitted by belts and not by countershafting. About the rights of this question there cannot be the slightest doubt. It has been proved over and over again by experience. At first sight it does not seem probable that a number of independent high-speed engines should be more economical or safer than a single large engine, say of the marine type. The explanation lies in the special conditions of central station lighting. Without dwelling upon the great loss of power due to countershafting with the large engine, it is only necessary to observe that the maximum load in a lighting station is many times as great as the average load. Thus, if the single engine be adapted for the maximum load, it is working underloaded during the greater part of the 24 hours. The consumption of steam in proportion to power developed is very high, and the engine is under these circumstances not an economical one. With the independent engines, on the other hand, none of them need at any time be working much under its best load, and when the load increases other engines and dynamos can be switched in, and they are thus always working at or near the most economical conditions.

It has been found from actual practice in electric light work in identical central stations that 20 per cent. more work is required in the case when countershafting is introduced.

It has also been proved, from the experience of numerous central stations, that during a considerable number of hours in the night the load on the engines and dynamos is only one-eighth part of the maximum load.

For these reasons it is found most economical to use with each dynamo an engine whose most economical load is something like 20 per cent. under the maximum load. Waste of steam is far greater with underloading than with overloading.

Another advantage of this system is that there is abundance of time for inspection of the machinery. The station is easily added to. A breakdown in an engine or dynamo does not stop the working of the station. There is one other factor of safety to which attention must be drawn. One of the most annoying accidents in an electric lighting plant is due to a short circuit on the mains. In overhead work this often happens by the falling of broken telephone or dead wires upon the mains. In this case a small independent engine is pulled up, and no damage is done. With the large engine the dynamo grinds on, and unless the cause of short circuit is burnt up, the dynamo is destroyed, or at any rate the whole of the working is put out of gear.

Now I have a word or two to say about dynamos and converters, the actual apparatus which are used in America. I attribute a great deal of the manufacturing success of American electric light plant to this, that they fix upon the types of machine that they are going to make, and then lay down machinery which will enable them to produce those types cheaply, and having thought out the system thoroughly in the beginning, they do not require to make a complete new type of machine for every order that comes in. They are then able to manufacture their machinery cheaply, and in such a way that every part is replaceable.

At this moment I think, if I had to choose between two dynamos of which one was a little better than the other in efficiency, but the other of which was manufactured in this way, I should be very much inclined to lean in favour of the one which was made by machinery, and of which all the parts were interchangeable, and of which I could get any one of the parts by return train by telegraphing for it. The convenience of such a machine is obviously great.

I have, for the benefit of those who are electrical engineers and manufacturers, put down some facts in connection with the three types of alternating current dynamo machines made in the Westinghouse works. There are three types, one for 650 lights, another for 1,300, and another for 2,600. The voltage of all is the same, 1,050. In this country there has been a tendency to use on the primary circuit a higher tension than that, 2,000 volts. But in the Westinghouse system they use 1,000 volts at the converters, and 1,050 is developed by the machines. The local pressure is reduced in the same proportion as has been done most generally in Europe—that is to say, in the ratio of 20 to 1. The 1,000 volts in America is reduced down to 50 volts in the lamps, and in this country the 2,000 volts has been reduced to 100 volts at the lamps. And here there is a question opened which must be decided immediately in the central stations which are going to be put down in this country, Whether you are going to take the full advantage, as Mr. Westinghouse does, of being able to carry your high-tension current in the mains?

The advantage is that you are able to save copper to a very large extent indeed, whether you use 1,000 or 2,000 volts, and then, as Mr. Westinghouse argues, he is able to use lamps of only 50 volts instead of lamps of 100 volts; that he looks upon as the greatest advantage he has gained by the introduction of the Gaulard and Gibbs' system. We all know that the higher the voltage of the lamp the shorter its life, and a 50 volt lamp is a far more perfect thing than a 100 volt lamp.

We are greatly troubled by the expense of lamps compared with their life. That is an expensive item in the supply of electricity, and a 50 volt lamp being far more economical, is it not desirable to follow the American plan and use the lower voltage? I am sure that electrical engineers generally will see that this is a point worthy of their serious consideration.

It may even be said that we are all to go yet further and reduce the voltage still more. Of that I am less certain; but there is another point which will occur to electrical engineers, whether it is not desirable to use the lamps which Mr. Bernstein has been perfecting, of very low voltage, placed in series. At present one of the most serious difficulties in introducing electric light for domestic purposes from central stations, is the cost of wiring houses. Now, if we place our electric lamps all in series, the cost of wiring will be very much diminished, and it becomes a question whether this is not the best arrangement. In this case the primary coils of our converters would be put in series in the same way as they were originally in the Gaulard and Gibbs' system. We shall then be doing what they were trying to do when they chose the series arrangement—viz., we should not be having the two primary terminals inside the house at a difference of potential at 1,000 or 2,000 volts, which would be dangerous, for no two conductors would have a greater difference of potential than 50 to 100 volts. If at the same time we use low voltage lamps, we shall get a longer life than even Mr. Westinghouse has obtained. It seems to me that there are grave reasons for considering most seriously the question of arranging all our lamps in series and the primary coils in our converters in series also.

But I am not here to put forward suggestions about what we may probably do in England, but only to point out what they are doing in America. I wish, at the same time, to guard myself against saying that they have the best possible arrangements in every way.

The construction of the Westinghouse dynamo is pretty well known in this country, and it is needless to speak of it.

I think we are probably all agreed that the old type of alternating current dynamo, such as the Siemens, has probably seen its day. One of the chief difficulties seems to be that when you have such a large number of coils revolving between the poles you are obliged to make a considerable clearance, and that causes you to use up a great deal of power in magnetising the field-magnets. Mr. Westinghouse makes a very small clearance, and in that way uses up only two per cent. of the maximum power in magnetising his field-magnets.

The Westinghouse Company make three types of dynamo, of which the following particulars are of interest:

Dynamo No.	I.	II.	III.
E.M.F.	1050	1050	1050
Current	35	65	130
Resistance (armature) at 30° C.	·76	·37	·15
,, (fields) ,, ,, ,,	14·5	7·0	3·6
Weight of wire in armature	17	30	60
,, ,, fields	420	...	...
Total weight	4800	9000	..
No. of lights	650	1300	2600

The No. III. has an armature about 2ft. diameter and 2ft. long. It has 16 poles, and runs at 1,000 revolutions per minute. The armature plates have each six large holes for ventilation and lightness. The weight of armature is 2,000lb. Mica is very largely used for insulating purposes, and shellac has been discarded in favour of copal (or coach varnish), which is a splendid material for this purpose.

The converters used by the Westinghouse Company are of five sizes, called by the numbers I., II., IV., VI., and VIII. The following

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table gives particulars about them. The size of wire is on the B and S gauge:

Converter	I.	II.	IV.	VI.	VIII.
No. of lights	5	10	20	30	40
Wire on primary	25	22	19	17	16
,, ,, secondary	11	8	8	8	7
Turns on primary	900	700	560	480	400
,, ,, secondary	45	35	28	24	20
Resistance of primary	48	21·9	9·9	7	5
,, ,, secondary	·04	·043	·0197	·0176	·0107
Weight finished (lbs.)	50	60	95	...	160

Thickness of iron plates = ·006 to ·0065 in.
,, ,, paper insulation = ·00025 in.
Number of plates in a No. 8 converter = 1350.
The iron used is Welsh Taggard iron.
50 deg. C. rise in temperature is allowed in the converters.

In this country the tendency is to make converters much larger; it has even been suggested that they should be made for thousands of lights. But for ordinary use in houses the Westinghouse system seems to be the simplest. Here we find that it is necessary to wire the houses in such a way as to suit our meters, which at present do not go over a range of from one lamp up to a thousand lamps, nor even up to hundreds of lamps, and if we find that our range is suitable up to 40 lamps it is very desirable to wire the houses in such a way that there are not more than 40 in the circuit of a meter indicating 40. It is probably for this reason Mr. Westinghouse has limited his converters in this way.

There are some points well worthy of attention in regard to converters. In the first place, by the use of only 1,000 volts, a far cheaper converter may be made, and thus a great saving may be effected in the plant required for a house. Then, again, there is the number of alternations. In the Westinghouse plant there are 16,000 alternations—that is, 8,000 complete periods per minute. In this country the tendency is to make the number of alternations less. The quantity of iron you put in your converters depends on the number of alternations; the greater the number of alternations the less iron is required, and you are therefore able to use smaller converters. I do not know whether or not there are objections upon other grounds to a high number of alternations. The only objection that occurs to me is that, while the construction of the dynamo sometimes becomes a little easier, it also takes a little more space.

Mr. Westinghouse asked me to make some tests for him on the efficiency of his converters. It has been supposed that converters have not a high efficiency when working at half-load. I may mention that the efficiency varied slightly in the different types, owing to the proportions of iron being greater in some types than in others; but at half-load in some cases we were able to get an efficiency of 95 per cent., which is a splendid result, and I think a greater efficiency than most people have been supposing was to be attained. I do not think that in actual practice there is an average waste of 10 per cent. in the use of converters, when they are properly designed. The formulæ which regulate the construction of converters has been given by me in the *Journal* of the Society of Telegraph Engineers and Electricians, February, 1888.

I may also say that Mr. Westinghouse has in his lamps 70 per cent. of the power given to the belt by his engine, which is a very good return for converters and alternating dynamos. This shows that the new alternating current machines are much superior to the old ones, which gave about 78 per cent. efficiency.

The wiring is nearly all overhead in the States. The wire used is called Simplex wire, and is made by a firm in Boston. It is very carefully prepared, and is, I think, beginning to be known in this country, and gives satisfaction.

For underground work Waring cable, which is lead-covered, is used with complete success. I am informing you now of what is being used, and used successfully, and what may be used successfully by us in this country; but you must not suppose that I hold that these arrangements are the best.

Now comes a most important point of distribution. Ought the conductors to be massed in one heavy main, with all the dynamos feeding it, or ought the mains to be subdivided, with, perhaps, several to each dynamo? or ought we to adopt an intermediate plan? The experience of the Westinghouse Company leads to the subdivision of mains as far as possible, because a short circuit on any main then endangers only one dynamo. By limiting the range of possibility of short circuits, great general security has been obtained.

I have often been asked the question whether alternating dynamos can be worked in parallel. They can when they are fully loaded, down almost to half load, but below that they do not synchronise. It is a very beautiful thing to see the way in which the phase is got. (Prof. Forbes then explained how a lamp was placed in circuit with the machines, how this kept brightening and dimming until at last it went out, when was the critical moment for coupling the dynamos.)

There is one thing that will probably be spoken about in the discussion which will follow my remarks, and that is the high speed of the Westinghouse dynamo. I think there is needless objection to high speed by engineers in this country. If we have a perfectly uniform cylinder of iron revolving, I have no objection to any rate of speed so long as I know the shafting will not give way.

The armature of the Westinghouse dynamo is extremely uniform in its construction, and so is capable of turning at the high speeds indicated in the table given above.

I think it would be desirable that some of the gentlemen present should give us their views as to the desirability of using a high or low number of alternations, high or low voltage in the primary, whether 50 volts will be desirable in use, and also as to whether subdivision of mains is desirable, and whether the converters should be supplied for only a limited number of lamps, such as 40 or 50.

I have now attempted to give you a general idea of working central stations in America on the system which has been most fully developed of late years. It is the result of a great amount of careful work, and in the work of the immediate future in England I am sure that English engineers will be benefited by the large practical experience which our transatlantic cousins have collected.

ON THE MEASUREMENT OF ELECTRICITY IN A HOUSE-TO-HOUSE SUPPLY.*

BY W. LOWRIE.

The supply of electricity from central stations has for years received a large amount of attention, but until within quite recently a practical house-to-house supply was impossible, owing to the enormous weight and cost of the copper conductors or mains required to convey large currents at low tensions to any considerable distance. The sectional area had to be very great to avoid a high percentage of loss due to resistance. This objection, which was fatal to any extensive venture in a house-to-house supply of electricity, has now been overcome by the introduction of high tension, alternating current, and secondary generator or converter system. By the employment of this system the current is so greatly reduced, and therefore the size of the mains is so lessened, that even in very long distances any loss due to their resistance may be reduced to a practicable minimum without any serious outlay of capital. One of the most important features in a house-to-house supply of electricity is a reliable method of a meterage to the different consumers. Now, even in the case of the old systems of low-tension continuous current circuits, the difficulties of meterage have hitherto not been satisfactorily overcome. The greatest difficulty in these systems, being the very high percentage of loss due to the passage of very large currents through the resistance offered them, by the coils or other mechanical appliances which have to be introduced into the circuit, rendering it impossible to obtain the full luminosity of the lamps. Or, in the case of an electro-deposition meter, the enormous quantity of copper carried from plate to plate, and consequently their large area and thickness which is necessary, and also the difficulties connected with the accurate weighing of these very heavy

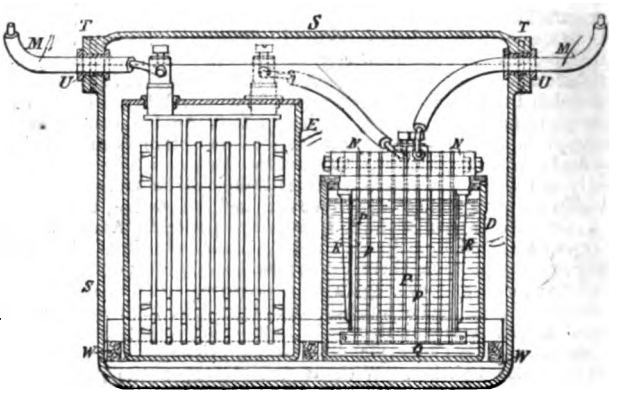

FIG. A.—Secondary Cell and Depositing Cell.

plates, are insurmountable objections. Still more difficult, has it been considered, to measure alternating currents, for they will neither deposit metals nor decompose liquids, and if any attempt is made to construct a mechanical meter, retardation is set up against the current to so great an extent, in the coil or coils necessary to control or act as a motive power to suitable mechanism, that here again insurmountable objections are met with. But it is the very fact of this inability of the alternating current to deposit metals or decompose liquids, which has hitherto been considered fatal to any system of meterage, which enabled Messrs. Lowrie, Hall, and Kolle, the inventors of the new system herein described, to form a most efficient and reliable method of electro-deposition meterage. This new system is the differentiation of the main or alternating E.M.F. This desired effect can be brought about in many ways, the one used now by Messrs. Lowrie and Hall in their house-to-house lighting system at Eastbourne being by the introduction of a constant E.M.F. into the said main or alternating circuit, which, whilst it reinforces the main E.M.F. in the half alternation in a direction positive to it, retards it in that direction which is negative to it; so producing a subsidiary or resultant extra current to the main or alternation current in that half alternation which is positive to the constant E.M.F. This subsidiary current must be necessarily exactly proportional to the main current or, what is the same thing, to the resistance of those appliances in which the electrical energy is expended. Thus, by putting a deposition cell in series with the source of the constant E.M.F., the amount of deposit will become available as a current measure. So that the fact of the current being an alternating one allows the use of a deposition cell (when the addition of a constant E.M.F. has been made); for where, as before pointed out, with a continuous current, the passage of copper would be excessively large, by the application of this invention to an alternating current this passage may be reduced to a minimum, so long as it remains sufficient for a practical measurement, for the said passage depends alone on the magnitude of the subsidiary E.M.F.

Having now described their method of obtaining an alternating current, in which the maximum current in one half of an alternation is greater than that in the other half in the opposite direction, we

* Paper read before the British Association at Bath.

will proceed to describe the practical method of obtaining from it the efficient method of moterage at present adopted by Messrs. Lowrie and Hall, and to give a detailed description of the appliances, and also the methods of obtaining constants, &c., and other matters appertaining thereunto. The sample meter before you is of the same type as that at present in use, and manufactured by the inventors; and Fig. A is a detailed drawing of the whole arrangement. The main, M, M, is severed as it proceeds directly from the dynamo, converter, or other source of electrical energy, to the lamps or other appliances in which the energy is expended, and the meter put across the break, so that the entire current which has to be metered passes directly through it. The current, on entering the meter, passes through the secondary cell, E, whose E.M.F. = 2 volts, so producing the necessary differentiation

FIG. 1.

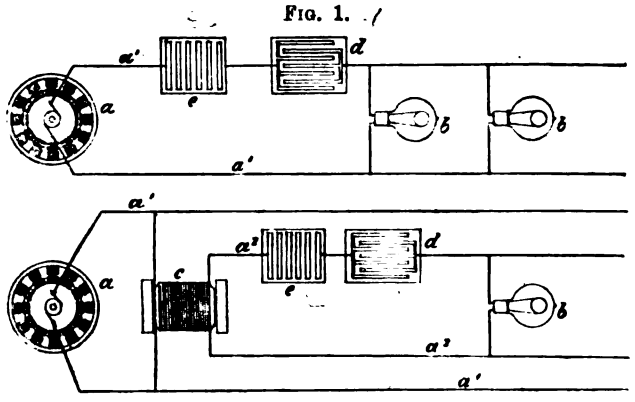

FIG. 4.

in the positive and negative directions in half of an alternation. That is to say, that supposing the E.M.F. of the dynamo or converter to be 100 volts, and the mean current to be 20 amperes: then in the half alternation positive to the constant cell at its maximum point:

$$\text{Total E.M.F.} = 202 \text{ volts.}$$

$$\therefore \text{ the maximum current } \frac{202}{10} = 202 \text{ amperes;}$$

while in the other half alternation:

$$\text{Total resultant E.M.F.} = 198 \text{ volts.}$$

$$\therefore \text{ the current} = \frac{198}{10} = 19{\cdot}8 \text{ amperes;}$$

so giving an effective current of ·4 amperes. But this current lasts for only one half of an alternation in the same way that an alternating current does, in consequence of its necessary fall from its maximum positive point to a neutral point in order to rise to its maximum negative point; so that although at its maximum point the effective current equals ·4 amperes, yet its average current is only ·2 amperes for all the time, or, which is the same thing, a current due to 2 volts only; so it is evident that the resultant current may be considered as one merely resulting from 2 volts constantly acting through the circuit resistance.

The application of this effective current takes place in the depositing cell, D, which is a cell in which the electrodes are of copper alternately connected together, and the solution a slightly acidulated saturated

FIG. 3.

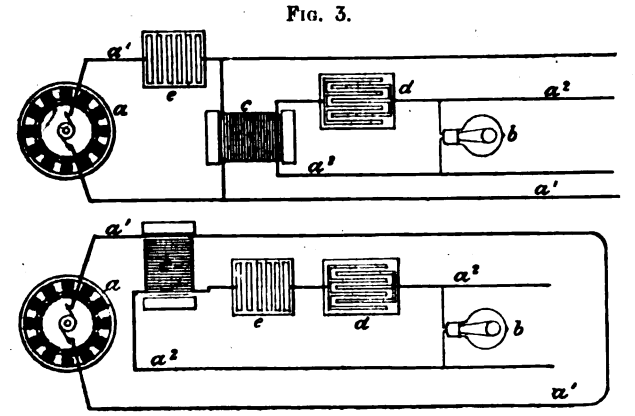

FIG. 2.

solution of recrystalised sulphate of copper in distilled water. The meter exhibited is one for a 20-16 c.p. 1,000 volt lamp installation, or for a maximum current of 12 amperes, the area of the plates being 48 square inches, giving an area of four square inches per ampere, which, with the strong solution used, gives a resistance quite neglectable. The capacity of the secondary cell is to register 400 units without recharging. The depositing cell is composed of an alloy unacted upon by the solution. The plates, P P, *p p*, are kept at equal distances by the distance-pieces, N N, by which also the connections are also made between the alternate plates, P P, a like connection being made by similar distances, which are not shown in the drawing, between the alternate plates, *p p*. They are also kept at equal distances by the slots in the vulcanite pieces, Q Q, supported by the metal bridges, R R, the exterior sides of the plates being coated with an insulating enamel, so that no deposition can take place upon them. The plates can be simply and easily removed for weighing purposes, &c., without danger of injuring the deposit, their removal being effected by releasing the nuts at the ends of the distance-pieces and the plates slid out.

The whole is contained in a cast-iron case, S, with the cover screwed down by the screws, T T, the cables entering through the insulating washers, V V, the insulation of the secondary cell and depositing cell from the containing case being effected by the insulating frame, W W.

To obtain the constants in the constant E.M.F. and depositing cell system, take, for example, an electric lighting circuit with an E.M.F. of 100 volts, and for a constant source of E.M.F., a secondary cell of an

FIG. 5.

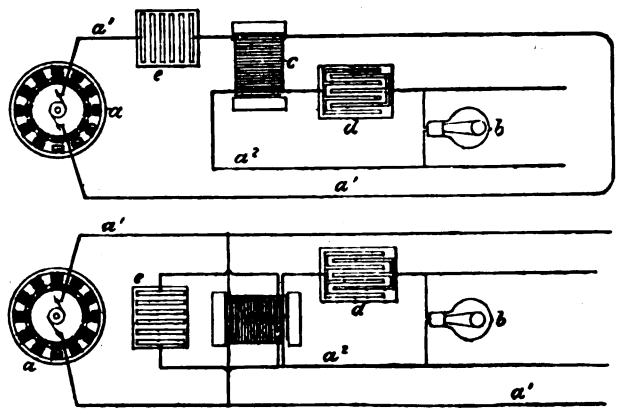

FIG. 6.

E.M.F. of 2 volts. Then, with an alternation in a positive direction to the cell, total E.M.F. = 102 volts.

And in a negative direction resultant E.M.F. = 98 volts.

So giving a difference of potential of 4 volts, for half the time of an alternation, as before explained. Therefore, in so far as the chemical action is concerned, the E.M.F. of the cell (*i.e.*, 2 volts) may be considered as working constantly through the resistance of the lamps. From this, the constants of grammes per unit or units per grammes are easily arrived at. Thus:

In a 100 volt circuit, with 10 amperes flowing, work = 1,000 watts.

And since resistance of exterior circuit = 10 ohms,

$\therefore$ the subsidiary current from the secondary cell $\frac{2}{10} = {\cdot}2$ amperes,

$\therefore$ the effective quantity of electricity passing through the electrolyte, with 1,000 watts in exterior circuit, for one hour (*i.e.*, one unit) = ·2 × 3,600 = 720 coulombs.

$\therefore$ the constant for a copper deposition meter is, during one unit of exterior work, 720 × ·000327 = ·23544 grammes of copper are deposited.

The requisite capacity of the secondary cell is only one-half that of the capacity calculated from the number of ampere-hours required to deposit the copper. Since the discharging current, when the current is positive to the cell, is that resulting from 4 volts, for half an alternation, more than 98 volts (*i.e.*, 2 volts from the cell + 2 volts from the dynamo); and on the negative alternation the cell is charged resulting from an E.M.F. of 98 volts. So that the charge of the dynamo neutralises the discharge, as leaving a 2 volts discharge

FIG. 7.

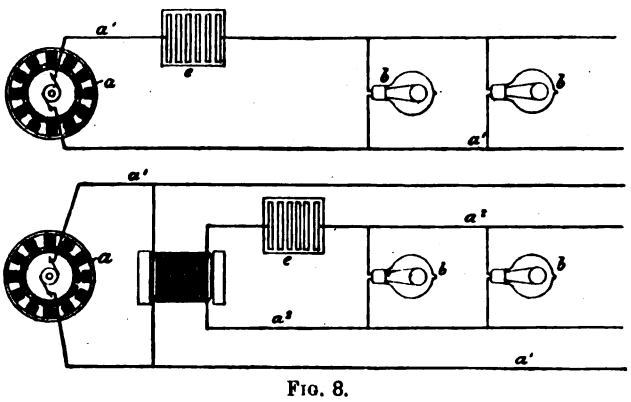

FIG. 8.

for only one-half the time. Given pure copper sulphate, and distilled water, and good copper, it is obvious that the meter must be absolutely accurate. But in consequence of slight impurities, which must necessarily occur, an error, certainly of not more than two per cent. may be deducted, so giving an accuracy, under ordinary conditions, of at least 98 per cent.

The use of copper in the depositing cells is quite optional, as any metal and solution may be used, by which any practical electro deposition may be obtained. Copper, however, is considered at pre-ent by the inventors to be the most convenient and cheapest electrodes. Various forms of self-reading of self-recording depositing cells are made, the usual form being a dial pattern, the needle of which is actuated by the alterations of the weights of the electrodes. Another form is that of a gas-meter, in which the electrolyte is decomposed by the passage of the subsidiary current, a graduated gauge-glass enabling a consumer to see approximately what his consumption may have been.

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In the preceding and other diagrams which will be described, a indicates the generator; a_1, the main circuit; a_2, the secondary circuit; b, the lamps or other appliances in which the electrical energy is expended; c, the secondary generator or convertor; d, the depositing cell; e, a constant E.M.F.

Fig. 1 is a diagram of an electro-lighting circuit coupled directly in parallel with the dynamo, as in the old low-tension system, with a constant E.M.F., e, and the depositing cell, d, placed in the circuit, so that all the current which has to be measured passes through them. The differential action of the current causes an electro-deposition of metal by the influence of the E.M.F., e, on the alternating or main E.M.F., which being exactly proportional to the amount of electricity passed through b, become a measure of the same as before described.

Fig. 2 is a diagram of a secondary generator or converter system, in which the primary circuits are coupled in parallel, the primary circuit, a_1, inducing currents in the secondary circuit, a_2, by means of a converter, c. The depositing cell, d, and the constant E.M.F., e, are placed in the secondary circuit, a_2, thus becoming a measure of the current, as before described in relation to Fig. 1.

In a secondary generator or converter system, the secondary cell may be introduced into either the primary or secondary circuit, the depositing cell being in all cases between the secondary coil of the converter and the apparatus in which the electrical energy is expended.

Fig. 3 is also a parallel secondary generator or converter system, in which the E.M.F., e, is placed in the primary circuit, a_1, and the deposition cell, d, is placed in the secondary circuit a_2. The differentiation of the E.M.F. produced by the constant E.M.F., e, in the primary circuit, a_1, is reproduced by induction in the secondary circuit, a_2, by means of the converter, c. Electro deposition results in the depositing cell, as before described.

The diagram Fig. 4 indicates one of several converters, $c\,c$, in series in the primary circuit, a_1, which induce currents in several secondary circuits, a_2 a_2, arranged in parallel with the appliances in which is expended the electrical energy. Both the constant E.M.F.'s, e, and the deposition cells, d, are placed in the said secondary circuits, and thus become a measure for the electricity passed, as described in the preceding figures, in each individual secondary circuit.

Fig. 5 is also a series secondary generator, or converter system, having the constant E.M.F., e, in the primary circuit, a_1, and the depositing cells, d, in each individual secondary circuit, a_2. The same differentiation of the E.M.F. produced by e being reproduced in induction, in the secondary circuits, a_2, by the converters, c, as hitherto described in connection with Fig. 3.

Fig. 6 is a parallel converter system—the constant E.M.F., e, in this case is used in a separate winding of the converter, c. This, in combination with the primary circuit, a_1, produces by induction, in the converter itself, the differentiated current in the secondary circuit, a_2, electro-deposition resulting in the depositing cell, d, as described previously in connection with Fig. 3. We may mention that to obtain this differentiation, instead of a secondary cell, a primary cell or a dynamo may be used, or any other means of obtaining the desired effect.

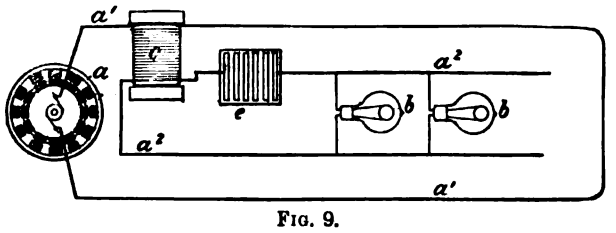

FIG. 9.

The following is an example of another method of meterage an apparatus connected thereto operating in the manner above mentioned, but using no deposition cell, the measurement being taken in the constant E.M.F. cell itself. Let it be required to measure the current duration of a number of lamps in a lighting circuit. We place in the lamp circuit, and in series between it and the generator, an electrolytic cell, which comprises two dissimilar metals, placed in an acid or alkaline solution. When an alternating current is passed through this cell and the lamp circuit, the passage or flow of the current is alternately retarded or reinforced by the normal E M.F. set up in the cell itself, which subsidiary E.M.F. causes a wasting or loss of weight of the positive electrode. As the resistance of the lamps in the lamps' circuit varies according to the number and kind used, and the duration of the flow of current through the same, so does the current vary in the cell which acts upon the positive electrode. This current is directly proportional to the E.M.F. of the cell and the resistance of the lamp circuit—the wasting away of the positive electrode, therefore, becomes available as a current meter.

Fig. 7 is a diagram of a similar low-tension circuit to that described in Fig. 1, but without the deposition cell, d. In this arrangement one of the electrodes of the constant E.M.F., e, loses weight proportional to the electricity passed through the lamp circuit, b, and this loss becomes a measure of the same as before described.

Fig. 8 is a diagram of a similar secondary generator or converter system as that described in Fig. 2, but without the deposition cell, d. The E.M.F., e, in the secondary circuit, a_2, has one electrode losing weight in the same manner as before described in the example of a low-tension system given in Fig. 7.

Fig. 9 is another series converter system similar to that described in Fig. 5, but without the depositing cell, d, the measurements being in this case obtained by the wasting away or deposition of the metal forming the electrodes of the cells, $e\,e$, producing the constant E.M.F. which causes the differentiation in relation to Fig. 7.

This differentiation may also be produced by mechanical means. One of these is the addition of a subsidiary coil upon the armature of the alternating dynamo, which is arranged and commuted—that is, cut out of the circuit during the second half of an alternation—or it may be so commuted that in the second half of the alternation its E.M.F. is in the opposite direction to that of the dynamo, so giving double the differentiation of potential that it would in the other case. The current is commuted at the neutral point of the alternation, so that no high-tension break occurs at any time.

Another method is to pass the alternating current having a magnetically saturated iron core, the result being that in the half alternation positive to the direction of the exciting current no retardation takes place, whilst that in the negative direction is retarded. To this latter method that described in Fig. 6 more properly belongs, except that in that case the exciting current is from the constant E.M.F., e, round the separate winding round the iron, instead of round a separate coil having an iron core.

In a secondary generator or converter system, where differentiation is effected by these means, the same differentiation is reproduced by induction, and an electrolytic cell or other means of measurement are put in direct series between the converter and those appliances in which the electrical energy is expended. This also can be applied in the diagrams 1 to 5, the arrangements described being substituted for the constant E.M.F., e.

ON A SYSTEM OF ELECTRICAL DISTRIBUTION.*

BY HENRY EDMUNDS.

The problem of the distribution of electricity has considerably occupied the attention of engineers lately, and several methods are in practical use, which may be classified as follows: The direct low tension, in which currents of large volume are transmitted, requiring correspondingly large conductors. This system has the advantage of extreme simplicity, but is limited in its operations to short distances from the source of supply. Another is the secondary generator or converter system, in which alternating currents of smaller volume, but much higher tension, are used, lessening considerably the weight of conductors, and getting over the limit of distance, enabling comparatively small wires to supply electric energy over a large area, but attended with increased danger to life and property from leakage, and neutralising the saving of cost in copper, in the increased cost of insulation and protection of the conductors. Both these systems are, however, subject to the annoyance of fluctuation in case of varying pressure or total extinction of light due to stoppage of machinery, when all work would cease. And if, in order to minimise such accidents, the generating plant be duplicated, the already large cost of machines, whose maximum output is only occasionally demanded, is enormously increased, thus adding to the capital invested and interest expected thereon.

In order to obviate the difficulties inevitably connected with any system of direct supply, of being always dependent on the continuity and regularity of the motive power, accumulators or storage batteries have been proposed; as it is seen to be necessary to have the equivalent of the gasholder to the retort, or the water cistern or reservoir to the spring or pump, in order to have a reserve independent of the source. This brings us to the question of how to supply batteries to the best advantage, and to examine into the methods hitherto employed on a large scale in connection with the public supply of electricity for lighting or other purposes.

In 1882 and 1883 I was in New York with the Brush Illuminating Company of that city, taking charge of the demonstration there of Mr. Brush's new system, which consisted in the employment of storage batteries, located in groups in series to each other, charged from a common main, carrying a 10 ampere current (the same being used to operate their arc lamps at night), devices being employed to automatically disconnect the batteries from the charging main when fully charged, and *vice versa*. The idea being by this method to obtain double duty from their existing illuminating plant, and enabling them to charge batteries by day and run arc lamps direct at night, the charged batteries at the same time supplying current for incandescent lighting. But in actual practice serious difficulties soon presented themselves. The current employed for charging was too small, and there was not time to charge the batteries sufficiently during the hours of day for any great demand that might be made on them at night. Suggestions were made to obviate this by charging a larger number of small cells in series, and discharging in multiple; but this demanded correspondingly higher voltage pressure in the mains and at the generating station, which presented very serious practical difficulties. Batteries being so charged could not be used to supply light locally at the time of charging, thus removing the great desideratum in electric service—viz., continuous supply—and, further, the risk of breakage and damage therefrom was greatly increased. Besides, batteries under charge have an increased voltage, which either injures the lamps or causes annoyance by fluctuation. Ultimately, after great cost and expense, this promising system was abandoned, and I learnt, when in the United States a few weeks ago, has never been revived.

In England, also, experiments on a large scale were made at Colchester about the same period. Here batteries were charged with a high-pressure charging current of small volume. Duplicate sets of cells were employed, so that one set was being charged from the main while the other was discharging locally. But again difficulties presented themselves in practice. The pressure at the station on the charging mains, being at least equal to the sum of all the batteries in series, was either very high or else limited, the number of groups on circuit that could be charged at one time, also the freshly-charged cells, having a higher E.M.F. than those that had been discharging caused serious fluctuation in the lights during the change from the charged to the local circuit. And as the cells automatically changed their position from the main to the local only when they had themselves arrived at a certain condition of charge, sometimes the local

* Paper read before the British Association at Bath.

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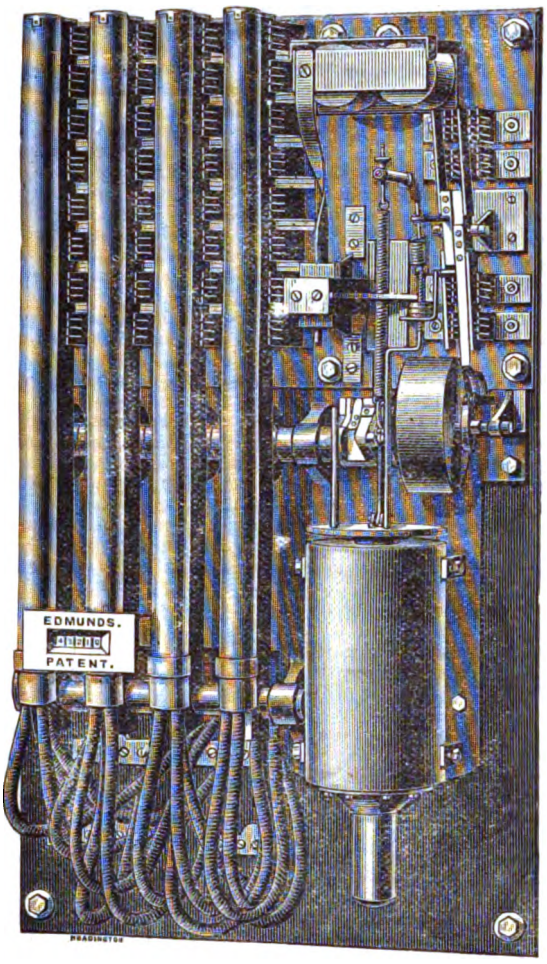
cells had got over-discharged causing serious damage through buckling and deterioration generally. The result was that the Colchester system was ultimately abandoned.

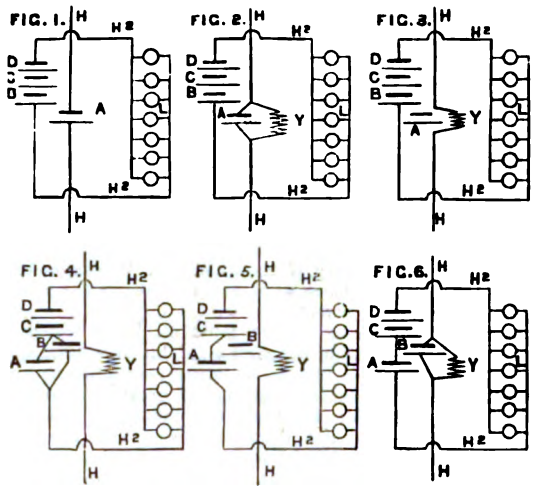
Having thus far glanced at the history of electrical supply, I now turn to the method proposed and patented by myself known as the Edmund's System of Electricity Distribution, such as is now being employed in actual practice by the Cadogan Electricity Supply Company, London. This system differs essentially in every point from any of the plans hitherto tried or in operation at the present time, and may be thus described: A number of groups of cells, which we will call the local batteries, are placed at different points or centres where supply is required in the district, each battery having its individual number of cells according to the voltage required locally, and the amount of current to be supplied. Unlike the Brush method referred to, these local batteries are electrically distinct and independent of each other and of the charging main, neither is there a duplicate set to be changed, as at Colchester, but instead we employ an additional group with each of the local batteries, which we will term the main batteries, the number of cells of which are a divisor of the number employed locally—generally one-third. For example, suppose the local voltage be 48 volts, thirty-two cells would be employed, which we would subdivide into four groups, eight cells in each, and for purposes of identification we will call these groups *a*, *b*, *c*, and *d* respectively. Groups *b*, *c*, and *d* are connected in series in the local (*see* diagram) giving 48 volts. Group *a*, being in the main, being charged for a limited period of time—in practice two



minutes—is then removed from the main charging circuit and placed in the local discharging circuit, when, say, group *b* is removed from the local into the main to be charged. *B* now in turn exchanges places with *c*, and *c* with *d*, so that each group *a*, *b*, *c*, *d*, follow each other in turn from the main to the local or local to main, whereby in every eight minutes each group has received its increment of charge from the main, and has supplied the same in turn to the local, and so on continuously, until in twenty-four hours each group has received its full charge of current, enabling the battery to maintain its maximum discharge for eight hours, the current employed in practice being 70 amperes, and the size of cells proportionate. Incidentally we find many advantages due to charging cells in this manner. We can maintain a constant potential on the local circuit, so that we have not the interference and fluctuation due to charging and discharging at the same time. The high-tension main is never at any time in electrical contact with the local circuit, thereby freeing the system from leakage to earth and its attendant danger. Also the cells are kept in much better condition by continually receiving short increments of charge and having periods of rest from discharge. The loss due to difference of potential between the charging and discharging current is minimised, it being found in practice we can continue charging the cell to its maximum capacity with a mean E.M.F. of 2·25, instead of 2·5 per cell, as is required where cells are charged continuously. This, on a large scale, is a considerable element of economy, where there are a number of cells in the charging main. Also we find that an approximately constant potential on the local circuit enables us to run lamps at a higher efficiency, without the risk of rupture due to sudden rises of pressure; and so far as we can judge the life of the batteries is considerably lengthened by this mode of intermittent charge and rest. And in addition to all these advantages we have a great saving in the generating station in cost of plant, only one-third the power being required to operate the same number of lights for eight hours that would be necessary for any direct system, and much less electric force or pressure on the charging mains to supply the same number of lamps, thereby saving cost of installation and reducing the leakage.

The additional advantage of being able to run a smaller station for twenty-four hours in the day is obvious, as we do not have any idle plant with interest thereon. The current being always constant in volume enables a single main of one size throughout to be used, preventing complications and only requiring increase of pressure as the work extends, which pressure would be only one-third the Brush or Colchester systems referred to, for the same number of cells in the local centres, or could at their pressure charge three times the number of batteries. For example, where batteries are used in 100 centres on the Brush or Colchester plan, each centre giving 50 volts, requiring at the station a charging potential of over 5,600 volts, exclusive of the line, while with the distributor plan it would only require a charging potential of under 2,000 volts for the same work.

The apparatus for carrying out this system I call a distributor. It combines in one instrument a time mechanism causing changes to occur at regular periods of say two minutes, by energising an electromagnet at each period, rotating a shaft carrying cams that cause levers to make the necessary contacts for changing the position of the cells from local to charge and *vice versa*; a polarised switch, whereby the current is prevented from entering the batteries in the wrong direction; and a voltage regulator, which causes the batteries as a whole to cut themselves out of the charging main or otherwise, according to their being fully charged or requiring charge. A simple form of meter registering the current is supplied. The diagram of the cycles of operation will explain what takes place, and I have constructed several distinct instruments for effecting these cycles, some with levers and mercury contacts, one with rotary brush contacts like a compound commutator, and the one shown in cut which we are now using, in the designing of which I have received great help from my assistant-engineer, Mr. Albert Howard.



The manner of effecting the cycles is explained by diagrams 1 to 6 A. B, C, and D represent the accumulators at one point of lighting, which are divided into four equal groups. For instance, imagine there are 32 cells in one house, then A group would consist of eight cells connected together in series, and B, C, and D the same.

In diagram 1, A is receiving a charge from the central station, over the main cable, and batteries B, C, and D are connected together in series and furnishing current to the lights B. After this state of discharge has been in operation for a fixed interval of time, the distributor begins to work automatically, and makes the various connections necessary, as follows:

Fig. 2. A resistance, Y, has been switched into the main circuit in parallel with battery, A.

Fig. 3. A has been switched entirely out of circuit, leaving the main current of 70 amperes, which have never been interrupted, flowing through the resistance, Y.

Fig. 4. A has been switched into parallel with B in the local or discharge circuit. This is done without the slightest alteration in the lights, as the E.M.F. remains the same as before.

Fig. 5. B has been cut out from the discharge circuit, leaving the lights on to A, C, and D.

Fig. 6. B has been connected into the main charging circuit in parallel with the resistance, Y.

The resistance, Y, is then disconnected, leaving the charging current flowing through B, which receives a charge for the fixed interval of time, and is then switched back into the local circuit, while C receives its increment of charge. In this way each section of the batteries passes through equal periods of charge and discharge.

The time occupied in the mechanical movements of the entire cycle is three-quarters of a second, and the period during which the charge is on can be varied at will.

Such a system as I have briefly described lends itself to many purposes in connection with electricity supply. For instance, in the

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working of railroad switches and signals, electrically, a distributor at each block station would enable a whole line of rail, say 200 miles, to be supplied from one source, the pressure on the main being only a small fraction of the sum of the local pressure, or in electric tramway work, a charged main, well insulated, of high pressure, could supply a number of points *en route*, which in turn could each, independently of the other, supply large volume low-pressure currents locally, saving risk of breakdown, and consequent interruption of traffic.

But more particularly is it useful in detached house and suburban lighting, for it solves the problem of giving each house its own individual supply of electricity continuously day and night, totally independent of continuous or regular working at the central station, or of interference from other work on the same circuit, being at the same time absolutely safe from the danger of shock, and, above all, supplying the electric light at a reasonable cost.

Discussion on the Papers of Messrs. Forbes, Edmunds, and Lowrie.

Sir William Thomson, referring to Prof. Forbes' paper, gave it as his opinion that 100 volt were to be preferred to 50 volt lamps. With reference to conductors, he said there was only about three millimetres thickness of them that was useful. The conductors should therefore, perhaps, be thin plates or tubes three millimetres thick.

Mr. R. P. Sellon, speaking as a manufacturer of incandescent lamps, thought that there was no doubt that the lower E.M.F. lamp was the longer-lived one. It was also more economical and easier to manipulate in manufacturing. It had a cross-sectional area many times greater than the high E.M.F. lamp, therefore the smallest inequality in the filament, or the smallest impurity in the carbon, must bear a much smaller proportion to the whole area than in the case of a small area or high E.M.F. lamp. He could corroborate what Prof. Forbes had said as to central station lighting in America, having paid a visit to that country. The Americans had this pull over English electric light engineers, that the gas interest there was very small, and, moreover, the gas was not as good as it was in this country. The Americans, too, were not so æsthetic as the English. He thought the ladies here were answerable for much of the ill odour attaching to the electric light. Having called attention to one or two points in the diagrams accompanying Mr. Edmund's paper, Mr. Sellon concluded by asking how much energy was lost in his automatic apparatus, as he understood he proposed to put one of them in each house?

Mr. S. F. Walker thought the 100-volt lamp was equally as good as the 50-volt one, and that it was a matter of perfection in the manufacture. In the early days, when the 30-volt lamp first came out, they were bad and broke very soon; but, with a greater perfection of manufacture, this difficulty was got over, and, as far as he knew, the 100-volt lamp was every bit as good as the 50-volt one. If it was a question of the economy of the two—as far as wiring, &c., went—he thought they had better save their copper and use a 100-volt lamp. He would even go further and say, use one of 200 volts. With regard to the Westinghouse system, he thought they must admire the energy and skill with which the whole thing had been worked out from end to end. Probably electric lighting would go ahead faster in this country if they had Mr. Westinghouse there. Would Prof. Forbes tell them what was to insulate the primary and secondary coils in the converters?

General Webber thought they must all be indebted to Mr. Edmunds for his admirable description of his automatic apparatus, and those who had known him for as many years as he had would be sure that his work had been the outcome of great pains and thought. In the last few months Mr. Edmunds had taken out some fifteen or twenty patents. He did not think, however, that the association should run away with the idea that distribution by accumulators had only been successfully carried out by the Brush and the B. T. K. systems, until Mr. Edmunds came before them. Mr. Crompton's installations were evidence that others had been at work on the question. They must reduce the value of Mr. Edmunds's system to the distributor, the rest had occurred to many people at different times. Those who were looking forward to accumulator stations, however, did not believe in automatic apparatus. There was no *raison d'etre* for a distributor. The great thing in bringing things like that before such a meeting was to be able to show that they were a success. He thought it would have been better if Mr. Edmunds had waited twelve months and ascertained that the apparatus had done its duty during that period.

Mr. Kapp, referring to Prof. Forbes' paper, said that the question of the best potential to use in this country was a very important one, and ought to be settled so that the contractor who had to put up central station work might have a choice of apparatus from various makers. The tendency in this country was to go for 2,000 volts for moderate plants. It was undesirable to have two standards here, and unless there was a good reason for using 1,000 volts, he thought they should stick to their 2,000 standard. They should endeavour to find a way of coupling machines in parallel; Zipernowski was doing it, and what what he could do they ought to be able to do. He would like to ask whether the transformers got hot, because that was a failing of theirs. The output of the Westinghouse transformer in comparison with its weight was not so very good—there were some that would give a lamp for every 2lb. of dead weight. Speaking generally, he thought the Americans used the apparatus, and they (English engineers) only made them.

Prof. Forbes, in reply, said he would like, before passing to the questions addressed to him, to make one remark on a statement contained in Mr. Lowrie's paper as to the waste of energy in alternate-current meters having hitherto been so great. He must challenge that statement as the maker of an alternate-current meter that had worked very satisfactorily. The resistance of this was $\frac{1}{100}$th of an ohm, and for thirty lamps it used up about half a volt. Passing to his own paper, he said that because he had been speaking of the use of alternating currents in America they must not think that he was advocating them. He was not advocating anything American, nor was he saying that everything there was right. They could do much better themselves here. With regard to accumulators they were working well then, but were still far too costly. The running of dynamos in parallel was, of course, known to Mr. Wild, and there had been various experiments in this country showing that it could be done. In the old days at the Grosvenor Gallery it had been tried with Siemens' machines, and they failed. The Westinghouse dynamo could be worked in parallel, and so could several others. He had seen the Thomson-Houston so worked. Dr. Hopkinson showed that alternating machines could work in parallel and not in series. The reason why they checked each other was that the lag in phase helped to check the one which was going too fast, and to check the force which was making the other go too slow, thus making it go faster. The Westinghouse dynamo had far more self-induction than the Siemens, and he thought that was why it was better than the other. At present two alternating current machines, driven each by a separate engine would, if they were once started in unison, keep in unison by the slipping of the belt. It was the slipping of the belt that allowed them to check each other. At the same time the checking effect was much greater when the maximum current was passing through the machines. It was only when they were doing a good deal of work that the synchronisation was perfect. If they were working much under half-load, the synchronisation was not perfect. As to the question of 50 volt *versus* 100 volt lamps, he would not express an opinion, but would leave it to be discussed elsewhere. In America the small potential lamps were thought best. As to the weakening of the steel in boilers by hydrogen consequent upon the use of gaseous fuel, he would say no more than that the statement was made to him that there was a deterioration of the steel. In reply to Mr. Walker, he would say that the Westinghouse converters were insulated with fibre and copal varnish, a superior class of coach varnish. Whilst speaking on the question of a 2,000 volt or a 1,000 volt standard,

Sir William Thomson remarked that the great benefit of a 2,000 volt standard was that they only wanted half the copper they did for 1,000 volts; and so if they had a 10,000 volt standard they would obtain ten times the benefit in this respect.

Prof. Forbes, continuing, said that one thing was certain, and that was that copper was a very much smaller item than cost of plant with high potentials. It occurred to him that they might possibly have a number of small stations of 1,000 volts going to short distances, in which case there would be no difficulty about copper mains; and, finally, perhaps, this might be combined into one large scheme. As to the heating of the transformers, 50deg. Centigrade was the greatest heat they were liable to, and the hand could be kept on them at that temperature.

Mr. Edmunds thought the lower voltage lamps were more useful than the higher ones, though he did not think there was much in longevity. Replying to criticisms on his own paper he said that the energy lost in the apparatus was not much, because the magnet which worked it was only in operation about three-quarters of a second. He felt that any kind of apparatus might stop or stick, and he had had a good many difficulties in connection with his, but it had been working now for some four months without attention and without a hitch.

Mr. Lowrie having answered several questions with regard to the working of his meter,

The **President** said he must enter a protest against the assertions that were made attributing the whole of the inaction in England to the Electric Lighting Act of 1882. That Act had in no sense or shape interfered with the action of corporations. There were sixty or seventy corporations who took out provisional orders under it, but they never carried them out. The fact was that electric lighting was not sufficiently advanced to justify them in investing money in it. Even there they had had the rival advocates of two systems—that of secondary batteries and that of secondary generators. He did not think there was a single independent electric lighting engineer who could recommend any of these systems as the best, and that was why they did not go ahead in that direction. He was in America four years ago, and they could not but be impressed with their wonderful activity, though he thought that it was better to work slowly and surely. As to the comparative values of the 100 volt and 50 volt lamps, he should make it his duty to recommend the formation of a committee to take into consideration all the features of the case. He was strongly in favour of the 100 volt lamps. They had, in the light of five years' experience, come to the conclusion that for isolated house lighting it was far superior. He would have liked—had he had time—to say something about Mr. Edmunds's apparatus. He thought it complicated at first, but it was really extremely simple, and he felt that when it had been rubbed down it would compare very favourably with other systems.

Electric Flour Mill.—The first flour mill to adopt the electric motor as its driving power is at Laramie, Wyoming. There is an Edison lighting station near the mill, and the machinery is run by Sprague motors from this source. The owners of the mill are members of the local electric light company who do the street lighting for the city. The surplus capacity of the electric light station was such that they used it for operating their flour mill rather than purchase an extra steam plant for the latter establishment. The mill is located about 150ft. from the electric light station. On the first floor of the mill are two Sprague motors, one of which belts to the main shaft in the basement, which drives the rolls, scalpers, bolts, and elevators. The other motor belts to a more rapidly running shaft on the next floor, which drives purifiers and cleaners and other machinery. The motors at full capacity require 226 volts and 150 amperes, and yield 45 h.p. The capacity of the mill is about 125 barrels of flour per day.

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LIGHTNING CONDUCTORS.

Sections A and G of the British Association met at the St. James's Memorial Hall at Bath on Tuesday, September 11th, for the purpose of holding a joint discussion on the subject of lightning conductors.

Prof. Fitzgerald, president of Section A, presided, and called upon Mr. W. H. Preece to open the discussion.

Mr. Preece said: It is a most remarkable thing that if we want to know much about atmospheric electricity, and its effects, we have to go back to the works of Benjamin Franklin—140 years ago. Scarcely anything has been done in this direction since that time. Up to the year 1881, there was not even a code of rules extant in the United Kingdom to guide people in protecting their buildings from the destructive effects of atmospheric electricity. It was proposed, in 1878, to establish a conference of various societies to discuss the effects of atmospheric electricity, and to form a code of rules for the erection of lightning conductors. All the manufacturers of this country, all the architects who are members of the Institute of British Architects, and the whole of the press of this country were invited to assist the conference in its labours, and the conference itself broke itself up into several sections; all works, English and foreign, were examined and abstracted, all rules and regulations then published were compared, and at the York meeting of the British Association in 1881 a report was adopted All the work of this conference was collected and published, and there does exist at this moment, published by Spon at Charing-cross, one of the most admirable works that ever has been collated on atmospheric electricity and its effects. If anyone really wants to know what to do in order to protect his house against lightning, he cannot do better than purchase this book, and he will find in it the results of the work of nearly everybody who has laboured in this field.

Now this report is divided into three parts. In the first part is discussed "the purpose which a lightning conductor is intended to serve." In the second part there is "a statement of those features in the construction and erection of lightning conductors, respecting which there has been, or is, a difference of opinion, and the final decision of the conference thereupon." In the third part there is drawn up a code of rules for the guidance of those who erect these conductors. I may say that this report itself is most decisive and is most important. There is a true ring about it; the ring of men who know what they have done and who know what they have been writing about. I cannot help reading out to you what will form the basis of a good deal that will be said to-day. This is how they define a lightning conductor: "A lightning conductor fulfils two functions—it facilitates the discharge of the electricity to the earth, so as to carry it off harmlessly, and it tends to prevent disruptive discharge by silently neutralising the conditions which determine such discharge in the neighbourhood of the conductor. To effect the first object a lightning conductor should offer a line of discharge more nearly perfect, and more accessible, than any other offered by the materials or contents of the edifice we wish to protect. To effect the second object the conductor should be surmounted by a point or points. Fine points and flames have the property of slowly and silently dissipating the electrical charges; they, in fact, act as safety valves. If all these conditions be fulfilled, if the points be high enough to be the most salient features of the building no matter from what direction the storm-cloud may come, be of ample dimensions, and in thoroughly perfect electrical connection with the earth, the edifice with all that it contains will be safe, and the conductor might even be surrounded by gunpowder in the heaviest storm without risk or danger. All accidents may be said to be due to a neglect of these simple elementary principles. The most frequent sources of failure are conductors deficient either in number, height, or conductivity, bad joints, or bad earth connections."

The paragraph ends with this most decisive and clear assertion, an assertion which I here defend, that is, that "there is no authentic case on record where a properly constructed conductor failed to do its duty."

Now, there we have defined the functions of a lightning conductor; and lest it should be thought that we had neglected the teachings of modern theorists, we assert here: "We will assume the conductivity of equal lengths and weights of iron in the case of steady currents of electricity, &c.," and further on we assert that "the suddenness of lightning discharge modifies the conductivity."

This report, I may say, is signed by Prof. Grylls Adams, Prof. Ayrton, Latimer Clark, E. G. Dymond, Carey Foster, D. E. Hughes, Hayter Lewis, W. H. Preece, G. J. Symonds, and Jeremiah Whitcord.

Now we have a great deal of experience in the performance of lightning protectors. I personally have under my supervision at this present moment 500,000 lightning conductors fixed throughout the Post Office system of this country, and we have our apparatus protected by about 30,000 lightning protectors. If 500,000 lightning conductors and about 30,000 lightning protectors are not sufficient to give a man a little experience, I want to know what will give him that experience!

There was a gentleman of the name of Mann, Dr. Mann, who practised the protection of buildings from electricity to a great extent in South Africa, and he made himself, to a great extent, associated with the introduction of a system. He was elected a member of the Society of Arts, and, when he died, in order to perpetuate his memory, his widow gave a sum of money to the Society of Arts on the condition that they gave lectures on some subject in which he was interested. Of course, we at once thought that there was no subject in which he took so much interest as atmospheric electricity, and when the lectures were to be given we had no hesitation in selecting as our mouthpiece one who is well known in this hall, who has lectured, we all know, with great effect, and whose power we are all prepared to bow down to—Prof. Oliver Lodge.

Prof. Oliver Lodge was selected to deliver a lecture at the Societ of Arts which should crack up and eulogise the report of the Lightning Rod Conference. But we produced, I am sorry to say, a veritable Balaam, who rode upon the British Ass., and instead of coming there to bless, he ended by cursing the report of the British Association. If all the vaticinations of Oliver Lodge were true, the work of this committee, and the work of the last 140 years, would be useless. No lightning protector would protect, and no lightning discharge could possibly be led to earth.

The strong assertions made by Prof. Lodge in his lectures before the Society of Arts in the *Philosophical Magazine* it is now my duty to bring before you.

In the first place, he assumes that a lightning rod forms part of a flash. Well, it does not. Nobody has ever seen, to my knowledge, a flash of lightning strike a conductor. The function of a lightning conductor is to prevent the possibility of its being struck by a flash; and if it were struck by any infinitesimal part of a flash, then I say that a lightning protector is not a protector—it has some defect in its construction that has to be remedied. But supposing it does, then the protector will form but a very small part, indeed, of the path of a lightning discharge from a cloud to the earth. A great deal depends upon the height of thunder-clouds. We see in text-books ridiculous assertions about the length of lightning flashes. Well, now, who can measure the length of a lightning-flash? There have been several extremely accurate measurements of the height of thunder-clouds. In South Africa, Dr. Mann measured them, and his measurement made the height 650ft. But the most accurate measurements have been made by Mr. Lacoiene, a French engineer, in charge of the Ottoman telegraphs at Constantinople, and there he makes the height of a thunder-cloud, and therefore the length of a flash, 325ft. We have thus two accurate measurements. During the late summer, whilst enjoying myself amongst the mountains of North Wales, I saw thunder-clouds, but no lightning. All those thunder-clouds, so far as I could judge, measuring by the eye as they passed fixed marks on the mountains, seemed to pass at about 500ft. I feel almost certain that the length of a lightning-flash in this country does not average more than 500ft.

We know, from the researches of Sir William Thompson, Warren de la Rue, and Hugo Miller, that the striking distance of steady currents is something like 30,000 volts per centimetre. This gives some approach to a general principle. If a flash of lightning were 500ft. long, and varied directly as the striking distance, then Oliver Lodge's measurements, given in his papers, would be fairly accurate. But there is every reason to believe that the striking distance does not vary directly as the distance: alternate currents are modifying our conceptions in every direction. There is a Mr. Acheson in America who has been making some very careful observations on striking distance across air. His currents are produced by transformers, and there he makes out that the striking distance varies, not directly as to E.M.F., but as the cube of the E.M.F. If that be so, then it will follow that the E.M.F. forcing a current of electricity through the air and producing a flash is very much less than we have hitherto considered it to be.

And, again, a flash of lightning always goes along a path that has been prepared for it. A flash of lightning does not go fooling about waiting for a convenient house to strike; it does not come down in a rush on every flagstaff and telegraph pole. We have ample evidence that wherever lightning flows there some preparation has been made for its approach.

Next, there is the assumption, and I consider it a fallacy, that a flash of lightning is instantaneous. We all know of the experiments that are made to show revolving wheels—the spokes suddenly appear before us fixed whenever a spark passes, and we most of us believe that the flash is really instantaneous; but there is no proof. All we know is that the flash is merely a flash of light, and that it indicates the path. How long the current lasts we cannot tell. There are dark and invisible flashes, as we may call them, and there are cases on record where people have been struck underneath trees when no light whatever has been seen. But I argue on the non-instantaneity of flashes from their effects on telegraph wires. Of course we have spread all over this country an enormous number of telegraph wires. Whenever a flash takes place, some wires are affected somewhere. It may not enter the wire; sometimes it does. There we always get currents of sensible duration. Then ships have often been struck, especially their lightning protectors have been a little defective; and it has been observed that compasses are turned about and go playing about whenever a ship passes through an electric storm. Now, it is impossible that the compass of a ship can be turned round unless there be a considerable duration in the flash. However, this is a point on which the photographs taken give a considerable amount of information; and during the discussion I hope Mr. Abercrombie will give us a sight of some very beautiful photographs that he has collected.

Now I come to, perhaps, the hardest nut to crack of all these questions put before us to discuss, one which I approach with a certain amount of diffidence because it is supported by very high authorities; it is the assertion that a flash of lightning is oscillatory in its character—that is, that it does not flow straight from the cloud to the earth and then disappear, but goes slashing about backwards and forwards—somebody says a million times in the second, but I am not going to discuss that—at any rate, that this flash goes flying backwards and forwards with considerable frequency. Now, I may say at once that this assertion as to the oscillatory character of the lightning-flash is based more on mathematical reasoning than it is on absolute observation. Well, I am not going to say much on the mathematical part of this question, first because I do not think it would interest you, and, secondly, because I do not think I am quite equal to it myself. I do not pretend to be a mathematician, although I am compelled in the discharge of my duties to use mathematics in some shape or other every day of my life. I make mathematics my slave, and do not allow mathematics to make me its slave. I am sorry to say that there are those amongst mathematicians who certainly make themselves the

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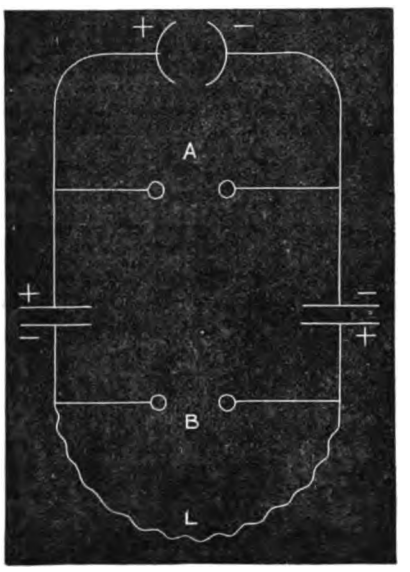
slaves of mathematics, and get into quagmires and sloughs of despond. We—I am speaking now of Section G—If I were a member (as I am) of the committee of Section A, I should feel hesitation in saying anything about mathematics, but I appear before you as president of Section G, and as an engineer, and I say we have no very great respect for mere mathematical development unless it is proved by observation and by experiment. Now, I will gives you one or two instances why we have some little hesitation in accepting mere mathematical developments. Fifty years ago, or more, it was proposed to cross the Atlantic by a steamer. It was mathematically proved that it was impossible for a steamer to cross the Atlantic. Some thirty-seven years ago, the Menai Straits, which carry the mails between Chester and Holyhead, was spanned by a tubular bridge. The greatest mathematician of the day, one of the luminaries of Cambridge, proved that it was impossible that the bridge could stand, and he used all his power to induce the Board of Trade to stop the passing of the bridge. I, myself, heard no less an authority than the Astronomer-Royal prove absolutely and completely—to his own satisfaction, not to ours—that it was impossible to lay a cable across the Atlantic; and I have also heard that a gentleman at this table, one of our greatest authorities, calculate by the conditions then at his fingers' ends the speed at which currents were likely to pass across the Atlantic, but it was found that a little condition was wanted which changed the whole aspect of the question: instead of our being able to speak across the Atlantic at the rate of eight or ten words a minute, it was found, to the surprise of everybody, that we were able to speak at the rate of 20 words a minute. These are instances to show why mathematical developments, devoid of practical experimental proof, should be received with a considerable amount of caution. And I think this theory, beautiful as it is, of the oscillatory character of a lightning-flash must be received with great caution. There are several facts against the theory. There is no doubt whatever that electro-magnets are powerfully excited for a sensible duration by lightning-flashes. We know that needles are magnetised and demagnetised; we know that electrolysis can be produced by lightning-flashes; I pointed out to you that the mariner's compass was caused to fly about. Sounds are produced. I have stood in a telegraph office and heard distinctly letters of the alphabet signalled by a flash of lightning. I introduced a quotation from Job in my presidential address: "Canst thou send lightnings, that they may go and say unto thee, Here we are?" I have heard the letter "r" most distinctly. I have also heard the letter "c." The letter "r" involves three current oscillations; "c" involves four currents. There is a case on record with the A B C instrument of Wheatstone of the letter "g" having been made; now, the letter "g" requires eight alternations in order to be recorded. And there are other effects. Hence I say that these durable effects on the telegraph wires are contrary to the oscillatory theory of the flash, unless the frequency of these oscillations be very small indeed. I say there are very great doubts as to whether it is true for lightning-flashes. It may be true for condensers or Leyden jars. But we are not dealing with Leyden jars, we are dealing with lightning-flashes; which, if they are analogous to anything in a Leyden jar, are analogous to the bursting of the dielectric, and not to the external discharge, where oscillations may occur. Of course, we have in a Leyden jar the dielectric with its charges of positive and negative electricity on each side of it in a considerable state of mechanical stress; and when that stress is suddenly removed, as it is by a spark, then it is not difficult to conceive that there may be mechanical oscillations in the dielectric. But I cannot conceive that this takes place in a flash of lightning which bursts through a mere layer of air.

Speaking once more upon oscillations, I may mention that we have distinct evidence of slow oscillations in a flash of lightning, and I think the photographs will also give you some evidence on that point; but Prof. Elihu Thomson, a careful observer, and one of the ablest men on the other side of the Atlantic, in a thunderstorm saw, by wagging his head about, or by shaking his glasses, six distinct flashes passing over the same path; therefore, there is distinct evidence of slow oscillations, but not of rapid oscillations. If that be the case, Oliver Lodge's ingenious speculation falls to the ground.

Now I will deal with another and extremely important point that Prof. Lodge has raised, and one of immense value. I may tell you now that while I am attacking Oliver Lodge with all my power and all my force, I am going also to pat him on the back with equal force. No man has worked so honestly and so thoroughly in this direction, and it is a true and real pleasure to carry on a discussion with a man who works with such harmony and good feeling as he does. Prof. Lodge has made some very beautiful experiments indeed to prove his case. He takes two Leyden jars, and they are charged with a Holtz machine. These new influence machines produce static electricity with great ease, and are charming instruments.

One of the advantages of this question being raised by Prof. Lodge is this—that it is dragging us all back to the early experiments we made in our youth when we first studied electricity and made experiments in static electricity, one of the most interesting and charming forms of electricity one can play with. There are two condensers. A Holtz machine charges one condenser with positive electricity, and the other with negative. Now, the experiment is this: If the balls of a discharger be connected with what Prof. Lodge calls an alternative path, L, either of iron or copper, then the length of spark flashing across the balls is very much longer than it is when there is no alternative path whatever. We go on charging, and the real discharge itself is determined by the balls, A. When a flash occurs through the discharge of these condensers, then there is simultaneously a discharge between B, and at the same time a discharge between A, and it is the discharge between A that determines that between B. Now, Prof. Lodge says that, owing to the oscillatory character of the discharge, we have in this conductor joining those two points self-induction—the alternative path—a kind of obstruction to the discharge which causes the charge to fly back through the discharger rather than follow the conductor. And his experiments are perfectly exact. I have repeated these experiments in every shape and form, and I have had them repeated by others, and in all cases his experiments are absolutely exact, and I do not question them—cannot question them—they are true. What I do question is the deduction he draws from his experiments, and there is a very great difference between an experiment and the deduction from that experiment.



Now, in order that the alternative path should influence the charge and discharge, there must be self-induction in that wire, and there must be frequency and oscillatory character in the charge or in the discharge. Prof. Lodge argues solely on the discharge, and arguing solely on this discharge his conclusions are right. But he does not take into consideration the charge. Now, I say the oscillatory character may be true or may not be true. For the sake of this argument I say it is not true as regards the discharge, and, therefore, Prof. Lodge's theory falls to the ground.

Here, however, in the charging current we have a Holtz machine, a machine that charges up by a series of consecutive minute charges of electricity. We have, in reality, a frequency of charge; little charges are sent pulsating through all the system. And here we have a wire possessing self-induction, in one case a wire of copper, in another a wire of iron. Prof. Lodge says that because the distance of the spark in the case of copper is greater than the distance in the case of iron; therefore copper has more self-induction than iron. I say that because the charge is a pulsatory charge, and that we have a greater spark with copper than with iron—there is a greater self-induction in iron than in copper. So that, arguing from the discharge, Prof. Lodge makes out the self-induction of copper to be greater than iron. I, arguing from the charge, make out that the self-induction is greater in iron than in copper.

There are many objections to this self-induction theory. There is no doubt whatever that Prof. Lodge in this inquiry has started an entirely new and fresh hare, which we electricians are bound to follow up, hunt, and kill. I know Oliver Lodge is on the brink of some discovery in connection with static electricity. I do not think his explanations are right, and I do not believe in the influence that he assumes for self-induction; in fact, I look upon the way in which lately self-induction has been brought into account for every unknown phenomena we meet with as a species of what the Americans call a bug. This self-induction is used in many different senses and different ways. Prof. Lodge himself, who is one of our shining lights on the subject—his papers, whether right or wrong, are always charmingly written and most interesting—but with all his care he cannot help speaking of this self-induction in various ways. In his paper I find he sometimes calls it electric inertia, sometimes electro-magnetic capacity, sometimes self-induction, sometimes self-induction of conductor, and also of discharge, sometimes inductance. We in the telegraph world have been familiar with self-induction for the last 20 years; we know it, as electro-magnetic inertia of the effect is always called retardation. Having two terms so well known as electro-magnetic inertia and retardation, I cannot understand why every writer on electricity is applying some new term to this phenomena. Its effects are expressed by a very simple formula, and to this it is very desirable that some name should be given. We practical men have without hesitation accepted the term applied to it by Lord Rayleigh, and we speak of it as throttling. Some people call it choking; but why it should be called impedance hindrance, we at present cannot understand.

I say Prof. Lodge has made a discovery. I do not know what it is. But he has neglected (being possessed of this mania, I will call it, for self-induction—he has had self-induction before his eyes and nothing else) to study Prof. Poynting's paper to the extent we might have expected. If he had, he could have applied Prof. Poynting's principle to his experiments, and proved with equal satisfaction to himself that the peculiar effects he produced are due to something or other in the dielectric.

But I am not sure that he will not find, on further inquiry into the matter, that there is something in the contact between the dielectric and the conductor. We know that the conductor, in contact with the dielectric, in contact with air, is subject to E.M.F.; we know that in the case of a row of people connected together, and a spark passed between

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them, those who suffer most are at the two ends. Cases have been recorded of a string of horses being struck by lightning, the two extreme horses being killed and the intermediate ones not touched. I think this is a point that deserves experiment. Wires may be obtained coated with the dielectric. I can supply Prof. Lodge with any quantity of wire covered with gutta-percha and paraffin.

Then, again, there is something analogous to transformation of energy in this experiment of Lodge's. Let his explanation be absolutely true; let there be self-induction in this alternative path, *l*. I cannot conceive from analogy any single effect of self-induction that would cause the E.M.F. between these two balls to increase from 100,000 to 140,000 volts. We have to account for that great increase of E.M.F. He spoke in his paper before Section A on Friday of a spark of 1in. at a distance of three yards increasing to 14in. There we have an increase of E.M.F. something like an increase from 100,000 to 1,000,000 volts, and we cannot account for that by any known phenomena connected with self-induction.

These points, I think, rather tend to shake one's confidence in the oscillatory character of lightning and the efficacy of lightning protectors.

The next fallacy of Oliver Lodge's is where he asserts that a lightning protector protects no area whatever. If a lightning protector raised above this building does not protect the aare round about this building, of what earthly use is that lightning protector? We know from the evidence given in the report of the Lightning Rod Conference that areas are protected, and I have, in a paper in the *Philosophical Magazine*, worked this out in a way that, I think, can scarcely be controverted.

Again, Oliver Lodge asserts that extended points are needless. Well, our report on the conference was that extended points were necessary. Of course, these two statements are diametrically opposed to each other. We place our stand on the experience of the past, and Oliver Lodge places his stand on his mathematical assumptions.

Next he advocates iron. So do I; but I do not like—I do not think any of us much like—sudden conversions. The most extreme Radical in this room did not feel very comfortable when he knew that Mr. Gladstone was converted to Home Rule; and when Oliver Lodge suddenly turned round and became an advocate of iron it was a very serious conversion. On November 3rd, 1887, in *Nature*, he says: "Hence, a lightning conductor should not be a round rod, but a flat strip, or a strand of wires, with the strands as well separated as convenient, and though I have not yet mentioned the special effect of iron, I may as well say here that iron is about 90,000 times worse than copper for the purpose of a lightning conductor."

Ladies and gentlemen, I said something just now about mathematical developments, and I think one of the serious errors committed by those who rely upon mathematical developments is that of hasty generalisations. This subject was dealt with last year by the then president of Section A. Talking about mathematical developments, he made his friend Mr. Querulous say that you had only to write down equations and scribble away until you got something or other. All the disputations of the learned never brought to light one fact of Nature before unknown; they are always elucidated by experiment. But there is no question of this, that mathematical developments in the hands of such masters as Prof. Fitzgerald, Lord Rayleigh, Sir William Thomson, and such experimentalists as Hertz, Lodge himself, and many others, are greatly opening our minds to the true character and true nature of electricity. We are gradually reaching a time when we can speak of the mechanical theory of electricity.

Prof. Fitzgerald made the subject of his address the fact that we have now absolutely proved the existence of an intervening medium for the transmission of those oscillations and those vibrations. We have in all effects of atmospheric electricity indisputable proof of the fact that we are dealing with energy in some form or other.

We all want to know where this wonderful energy comes from that is so destructive in a flash of lightning. We see trees and buildings thrown to the ground, men and beasts killed, and other terrific effects produced. Where does this enormous force come from?

Take aqueous vapour that comes in clouds from the ocean; it comes in contact with a stratum of cool air, the aqueous vapour will be condensed into rain and will fall. If that rain falls at the rate of 1 mm. per acre per hour, it developes energy equivalent to 600 h.p. per acre. Spread this over a county and you get millions of horse-power; and you see in that simple operation of condensation of vapour a power which only requires mathematical development to develop into a true mechanical theory of electricity.

I have always held that we should sooner prove an electric current to be a mere oscillation of the molecules that compose the mass of our conductors. I carried out in M. De la Rue's laboratory a series of most brilliant experiments with his great battery in deflagrating great pieces of wire. These were laid flat between white paper, and the result of deflagration showed that upon white paper you have distinct indications of nodes, of the passage of the current through the conductor bursting it in the form of waves.

Prof. Hughes, who is a marvellous man with his fingers, has been making a study of this subject; and we have been working in the same direction. The notion we had was this: in order to account for heat, light and electricity, and the difficult crux of the whole question, the duality of electricity, we always laboured under the notion that the motion in an electric current was of a spiral character, that of a right and left-handed screw, one direction being positive electricity and the other negative. I throw that out as a suggestion that deserves to be investigated.

I have done all I can to put this matter clearly before you. I have feebly shown Oliver Lodge's conclusions to be in some respects fallacious. I know he will say they are not. I know he will respond and give me one between the eyes if he can; but I hope he will do it gently, knowing the difference in size between us. Whether the result of this conference is to establish the truth of the position taken up by the Lightning Rod Committee, or whether Prof. Lodge will succeed in extricating himself in the position in which I leave him, I am certain that it will bring to the front what we are all anxious to see, the true theory of electricity shadowed forth by Prof. Fitzgerald in his inaugural address, an address which will mark this meeting of the British Association as an epoch in the history of electricity.

(To be Continued).

CITY NOTES.

Dissolution of Partnership.—Messrs. Robertshaw and Sunderland, electrical engineers, Halifax, have dissolved partnership.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ended September 14 amounted to £4,406.

West India and Panama Telegraph Company.—The estimated traffic receipts of the West India and Panama Telegraph Company, Limited, for the half-month ended September 15, 1888, are £2,479, as compared with £2,065 in the corresponding period of 1887.

NEW COMPANIES REGISTERED.

The Sheffield Telephone Exchange and Electric Light Company, Limited.—Registered by Meredith and Co., 8, New-square, Lincoln's-inn, with a capital of £60,000 in shares of £10 each. Object: to purchase from John Tasker, of Sheffield, the goodwill of the Sheffield Telephone Exchange, and also the electrical and other business carried on by him. The first subscribers are:

	Shares.
J. Tasker, manufacturer, Sheffield	1
J. Gamble, manufacturer, Sheffield	1
G. Senior, manufacturer, Sheffield	1
J. B. Jackson, manufacturer, Sheffield	1
G. Franklin, accountant, Sheffield	1
J. Jones, manufacturer, Sheffield	1
J. F. Smith, timber merchant, Sheffield	1

The first three and the fourth signatories above and Mr. William Tasker shall be the first directors. The number of directors shall not be less than three nor more than six, and the qualification of a director shall be the holding in his own right of at least 20 shares in the capital of the company. The remuneration of the directors shall be £300 per annum.

PROVISIONAL PATENTS, 1888.

SEPTEMBER 7.

12,918. **An improved method and principle of constructing secondary batteries or accumulators.** Edward George Rivers, Rosslyn Clevedon, Somersetshire.

12,935. **A new or improved electrical burglar alarm.** Alexander Calipé, junior, 19, Poland-street, London.

12,963. **An improved telephone.** Jacques Paul Zigang, 35, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 8.

12,986. **An improved electric or galvanic sponge or pad for stimulating and curative purposes.** Randal Cresswell, 97, Newgate-street, London. (Complete specification.)

12,988. **Generating a motive power by means of an apparatus called a "Thermo automotor."** Fredrich Gustav Adolph Horstmann, 13, Union-street, Bath, Somersetshire.

13,000. **Improvements in electric batteries.** Thomas Moriton Sargeant and Oswald Ricketts Swete, 47, Lincoln's-inn-fields, London.

13,008. **Improvements in electric incandescent lamps with interior reflectors.** John William Oldroyd, 8, Quality-court, Chancery-lane, London. (Complete specification.)

SEPTEMBER 10.

13,032. **Improvements in telegraphy and in apparatus therefor.** George Allan and James Wallace Brown, 4, Clayton-square, Liverpool.

13,035. **Improvements in the construction of socket electric lamp holders, wall-sockets and electric lead connectors.** Charles Mark Dorman and Reginald Arthur Smith, 24, Brasenose-street, Manchester. (Complete specification.)

13,038. **Improvements in facilitating the circulation or flow of electricity in and between animate and inanimate nature.** George Quarrie, Bournbrook, Birmingham.

13,061. **A new or improved combined telegraphic and telephonic apparatus.** Jules Cerpaux, Pierre Borre, and Leon Martens, 33, Chancery-lane, London.

13,063. **Improvements in electrical indicators for use on vehicles, or for other analogous purposes.** Edward Samuel Deanfield and Charles Graham, 1, Parsons Mead, Croydon.

13,076. **Electrical signalling apparatus.** Frank Jacob, 28, Southampton-buildings, Chancery-lane, London, W.C.

13,078. **An electric resistance meter and rheostat.** Urbain Eugene Guérin, 28, Southampton-buildings, London.

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SEPTEMBER 11.

13,122. **Improvements in the armatures of dynamo-electric machines.** Edward James Paterson and Charles Friend Cooper, European Works, Pownall-road, Dalston, E. (Complete specification.)

13,126. **Improvements in electric calls.** Willard Henry Cutting, 23, Southampton-buildings, Middlesex, (Complete specification.)

13,128. **Improvements in electric railway signalling systems.** Joseph Irwin, 226, High Holborn, London, W.C. (Complete specification.)

13,145. **Improvements in incandescent electric lamps.** Ernest Böhm, 45, Southampton-buildings, London, W.C.

SEPTEMBER 12.

13,191. **Electrodes for electrolytic operations.** Emile Marie Hippolyte Andreoli, 62, Loughborough-park, Brixton, S.W., Surrey.

13,192. **Electrodes for bleaching vegetable substances by electricity.** Emile Marie Hippolyte Andreoli, 62, Loughborough-park, Brixton, S.W., Surrey. (Complete specification.)

13,193. **Bleaching paper pulp by electrolysis.** Emile Marie Hippolyte Andreoli, 62, Loughborough-park, Brixton, S.W. Surrey. (Complete specification.)

13,194. **Bleaching China grass, rhea, &c., by electricity.** Emile Marie Hippolyte Andreoli, 62, Loughborough-park, Brixton, S.W., Surrey. (Complete specification.)

13,208. **Improvements in the use of incandescent electric lights.** Charles Wells, 22, Southampton-buildings, Chancery-lane, W.C., Middlesex.

13,215. **An Improvement in electrical batteries.** William Clark, 53, Chancery-lane, London. (Louis Maiche, France.)

13,218. **A method of preventing the deposition of crystals in the electrolytic fluids of electric batteries, the said method also allowing of the strength of such fluids being increased beyond their normal strength or that of ordinary saturated solutions.** Ernest Lower Berry and Felix d'Arc, 23, Andalas-road, Clapham, S.W.

13,221. **Improvements in mechanical telephones.** George Frederick Redfern, 4, South-street, Finsbury, Middlesex. (George Frederick Shaver, United States.)

13,223. **Improvements in or relating to electrical alarm-clocks and indicators.** George Scarlett, 6, Lord-street, Liverpool.

COMPLETE SPECIFICATIONS ACCEPTED.

SEPTEMBER 13, 1887.

12,418. **Improvements in conveying electric energy, and in applying the same to the production of motive-power.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London, W.C.

12,419. **Improvements in electric railways.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London, W.C.

SEPTEMBER 14, 1887.

12,437A. **Electrical measuring instruments.** Rookes Evelyn Bell Crompton and James Swinburne, Arc Works, Chelmsford. [Note.—This application having been originally included in No. 12,437, dated 14th September, 1887, takes, under Patents Rule 23, that date.]

SEPTEMBER 28, 1887.

13,154. **The application of electricity to the controlling of gas and other cocks and valves.** Henry Reuben Fisher, 35, Waterloo-road, London, S.E.

OCTOBER 6, 1887.

13,561. **Improvements in electricity meters.** Harold Werner Kolle, 433, Strand, London, W.C.

OCTOBER 19, 1887.

14,226 **Apparatus for measuring electric currents or electrical counter.** Marie Jules Raoul Jacquemier, 28, Southampton-buildings, London, W.C.

OCTOBER 25, 1887.

14,509. **Improvements in apparatus for measuring temperature on the absolute scale by means of change of electrical resistance.** Hugh Longbourne Callendar, Trinity College, Cambridge.

NOVEMBER 7, 1887.

15,158. **Improvements relating to electric safety-lamps.** James Sinclair and John Price Rees, 45, Southampton-buildings London.

NOVEMBER 23, 1887.

16,087. **An electric contact-maker, particularly applicable for use in connection with coin-freed apparatus.** James Salter Farmer, 4, Mansfield-chambers, 17, St. Ann's-square, Manchester.

MARCH 14, 1888.

3,986. **An improvement in plates for secondary voltaic batteries.** Bernard Mervyn Drake and John Marshall Gorham, 28, Southampton-buildings, Chancery-lane, London, W.C.

APRIL 14, 1888.

5586. **Improvements relating to holders or supports for electric incandescent lamps and to contact-devices for use therein.** Henry Harris Lake, 45, Southampton-buildings, London. (Claude Grivolas, France).

AUGUST 7, 1888.

11,403. **Improvements in apparatus for the propulsion of vehicles by electricity.** Henry Harris Lake, 45, Southampton-buildings, London. (Francis Joseph Weis, United States.)

AUGUST 14, 1887.

11,705. **Improvements in apparatus for measuring electric currents and recording the amount of electric energy consumed in a given circuit.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Westinghouse Electric Co., United States.)

SPECIFICATIONS PUBLISHED.

1887.

13,720. **Effecting electrical measurements and contacts.** A. De Khotinsky. 4d.

15,455. **Connecting separate electrical conductors to one main conductor.** W. S. Rogers. 8d.

1888.

713. **Voltaic batteries.** T. Coad. 8d.

7619. **Primary electric batteries.** G. J. Weir. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	101
12 Feb.	1/2	Anglo-American Brush E.L.	4	3
12 Feb.	2/0	— fully paid	5	4
27 July	1%	Anglo-American	100	44
27 July	2%	— Pref.	100	73
12 Feb., 85	5/0	— Def.	100	15¾
28 June	3/0	Brazilian Submarine	10	13¼
14 June	1/0	Con Telephone & Main	1	1/16
10 Aug.	9/0	Cuba	10	13¾x
10 Aug.	10/0	— 10% Pref.	10	19½
28 Mar.	2/2½	Direct Spanish	5	4
28 Mar.	5/0	— 10% Pref.	5	10¼
27 July	2/0	Direct United States	20	10½
27 July	4/6	Eastern	10	12½
27 July	3/0	— 6% Pref.	10	15
1 Aug.	5%	— 5%, 1899	100	110
26 April	4%	— 4% Deb. Stock	100	108
12 July	2/6	Eastern Extension, Australasia & China	10	13
1 Aug.	6%	— 6% Deb., 1891	100	107
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	103
28 Mar.	8/3	German Union	10	9½
10 Aug.	3/0	Globe Telegraph Trust	10	7⅛
10 Aug.	3/0	— 6% Pref.	10	14⅛
30 April	5/0	Great Northern	10	14
30 April	5%	Gt. Northern 5% Deb., '83.	100	109
27 July	10/0	India Rubber, G. P. & Tel.	10	17¼
11 May	37/6	Indo-European	25	39
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
		Swan United	3½	2¼
10 Aug.	13½%	Submarine	100	140x
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	8
1 Mar.	5%	— 5% Debs.	100	99
12 July	4/0	West Coast of America	10	8
30 June	8%	— 8% Debs.	100	115
11 May	9/0	Western and Brazilian	15	12¼
11 May	6/10½	— Preferred	7½	7
11 May	2/1½	— Deferred	7½	5½
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	1⅜
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80		— 6% 2nd Pref.	10	9
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	105

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NOTES.

Telegraphs in Central Asia.—It is stated that a new line of telegraph will shortly be laid down in Central Asia, between Khiva and Chardjui, on the Amu Daria.

Electric Execution.—The New Zealand Government have given a pledge to consider the advisability of executing criminals by some species of electrical application.

The Sultan of Turkey.—We understand that the Sultan of Turkey has given another order to Mr. Magnus Volk, who has also received from the same quarter an invitation to go to Constantinople.

Electric Launch Business.—We understand that Mr. Magnus Volk has joined Messrs. Immisch in order to manage the electric launch part of their business, which is to be prosecuted with great vigour.

Electric Smelting.—M. Jules Dreyfus has lately been occupying his attention with the production of improved apparatus for the electrolytic manufacture of aluminium and other alloys, and the construction of the best forms of crucibles.

Birmingham.—We are assured that the reports circulated in various daily newspapers of electric locomotives running in Birmingham are unauthentic and inaccurate. Proper details will be furnished when the actual trials take place.

Southend.—It is thought possible an electric railway will be introduced at Southend. A letter from Messrs. Latimer Clark, Muirhead and Co., Limited, was read at the last Local Board meeting, offering to supply particulars of electric tramcars.

The Best System.—Another best system in the world has come out in America. This time it is the Loomis of New York, Boston, and Kansas. Is it not about time that companies took to giving accurate particulars of their systems, with references to plants installed, and left these superlatives alone?

Breakage of an Atlantic Cable.—The Anglo-American Company's Brest-St. Pierre cable broke last Monday. This is the old 1868 cable, which was only repaired on the 28th of July last. It has always been a source of trouble and expense to the Anglo-American Company—in fact, a new cable could have been laid with the money expended in repairs of this cable.

Changing His Mind.—The latest hobby of Prince Holkar is the electric light. An engine, with all the necessary apparatus, was sent out from England, and a considerable portion of the lamps, &c., had been erected, when suddenly this prince stopped the work. So the whole of the plant has been taken up and returned to Bombay, the Maharajah paying ten thousand rupees for his little freak.

Poole.—An application was made from Messrs. Lawrence, Paris, and Scott (the Poole Electric Light Company) for permission to erect iron standards in different parts of the borough for carrying wires for electric lighting, which was granted on the understanding that the council could order the removal of the standards by giving six months' notice, and that the company should pay as rent one shilling per annum per standard.

Littlestone-on-Sea.—A London company has bought a large amount of freehold land at Littlestone-on-Sea, near the ancient Cinque Port of New Romney, the auctioneers being Messrs. Charles and Tubbs, 17, Basinghall-street, E.C. High-class residences, bungalows, and shops are to erected; a handsome road, 100ft. wide, has been commenced. The owners have decided to run an electric tramway service from the sea-front to the town of New Romney, which is the oldest of the Cinque Port towns.

St. Olave's, Southwark.—At the meeting of the St. Olave's District Board of Works last Tuesday a letter was read from an electric lighting company on the subject of lighting the district with electric light. Mr. Lafone urged the board to raise no objection to the proposal. The company, he said, proposed to lay all wires underground. He was sure the death-rate would be considerably less than it was at present if the "abominable gas" were done away with. He hoped the board would give the matter their serious consideration, and assist the company in every possible way. The letter was referred to committee for consideration and report.

The Manchester Exhibition.—The report of the Executive Committee of the Manchester Royal Jubilee Exhibition has just been issued, and in it the cost of the electric lighting is put down at a little over £10,000. It seems that this electric installation was in reality one of the largest erected up to the present in this country, comprising, as it did, 512 arc and 3,570 incandescent lamps, the former being in use 556 and the latter 560 hours. The Anglo-American Brush Company supplied the arc lights, and the Manchester Edison-Swan Company the incandescent lamps. The committee state that during the whole of the time no electrical failures occurred, and that the lighting was extremely satisfactory. The electrical contractors are to be congratulated upon this happy result.

Compressed Air.—More than one engineer of repute favours transmission of power by means of compressed air rather than by the aid of water or electricity. A company is in operation at Paris for the distribution of power by means of compressed air, and the works of the company are lighted by electricity. Messrs. Davey, Paxman and Co., of Colchester, supply nine out of the thirteen boilers used, and six 350-h.p. engines. The lighting is from a Gramme dynamo, driven by a vertical 25-h.p. engine, while another horizontal engine of 40 h.p. is also used to drive a second Gramme dynamo, and for trials with dynamos. The works cover an area of 2½ acres, but the adjoining property of Mr. Popp is also lighted from this centre. An electrical laboratory and dark chamber for photometrical work forms part of the establishment.

Flint.—The chlorate of potash factory, which forms part of the extensive chemical works of Messrs. Muspratt Brothers and Huntley, Limited, at Flint, has recently been lighted by electricity. The dynamo is one of Messrs. Mather and Platt's "Manchester" type. The engine is regulated by one of Hartnell's automatic regulators, and made by Messrs. Marshall and Son, Gainsborough. The switchboard is fitted with a gravity voltmeter, by Schuckert, of Nuremberg, and is arranged that either circuit can be switched on separately, with a "cut-out" in both positive and negative. The railway siding is lighted up by five lamps of high c.p; the dynamo room by 16-c.p. incandescent lamps, which are also in use in other rooms throughout the building. The inside lamps vary in c.p. from 16 to 50, and altogether make up an installation of between 60 and 70 lights.

Electricity for Edinburgh.—In commenting upon an article upon recent progress in electric lighting, the

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Edinburgh *Evening Dispatch* laments that Edinburgh should be so backward in adopting the electric light, and suggests that power could well be obtained from the city river. "That this country should have been so slow in coming to the new light, and that Edinburgh should be almost in the rear of all in availing itself of this beneficent discovery of science, is not very creditable to us. The opinion has been expressed that there is no city that could be more easily and effectively lighted by electricity than our own; and that in the Water of Leith, which the municipality are so tardily setting about to purify, there is motive power sufficient to supply the wants of the population." We should be glad to see some competent electrical engineers taking this question up, as it is now in a fair way to be done, with the similar water-power in the town of Bath.

Mechanical Vacuum Pump.—A new mechanical mercurial vacuum pump has been devised by Mr. J. A. Rudge, of Bath. It combines the two principles of operation—the mechanical, used when rapid exhaustion is required, and the mercurial, when the vacuum is wanted as perfect as possible, as in the case of incandescent lamps. This pump is double acting, and has only two valves, the one of oilskin above the piston, and the other of indiarubber inside the piston. When the handle is turned the piston is raised, and the air driven out of the upper valve. The air from the vessel to be exhausted enters below the piston. The piston is hollow, and there is a quantity of mercury in the bottom of the cylinder. When the piston descends, the air is driven through the hollow piston and out through the hollow rod. The mercury follows, and effectually prevents any air returning. When the piston is again raised, the space between it and the mercury may be regarded as a Torricellian vacuum. Mr. Rudge has received four medals for air pumps. The pump is said to be of great efficiency in the quick exhaustion of incandescent lamps.

The Maxim-Weston Co.—Elsewhere is given the gist of a report from the directors of the company to the shareholders. The report is not pleasant reading, but the principal feature is the suggestion to reduce the capital of the company by cancellation of 2s. 6d. per share upon the existing 5s. per share, and to provide working capital by issuing further shares at 2s. 6d. each. When the assets of the company are considered, and the past method of estimating assets and preparing balance-sheets, it will be seen that our contention all along has been correct, that the business was not carried on in accordance with generally-approved principles. The company was started with a flourish of trumpets. The names of John Pender and Sir J. Anderson will be found upon the original prospectus, but these wily gentlemen, like the proverbial rats, left the ship, and have earned none of the flattering encomiums that have been showered down upon Mr. Hugh Watt. The record of the final attitude of the latter gentleman is found in the report of the directors, and it will be well if the trio of admirable Crichtons does not further add to the unsavoury history of electrical companies.

A Competitor to Electric Railways.—The switchback railway is not to be a toy merely, it appears. The energetic switchback promoter, Mr. L. A. Thompson, of Philadelphia, who has introduced the switchbacks to so many of the exhibitions and sea-side resorts, has perfected the working details by which a gravity railway is to be used for rapid overhead passenger transit in towns and cities. The inclines are arranged in lengths, about equal to those between the city stations. Attached under each car is an automatic gripping arrangement. At each station there is a continuous moving cable running over rollers, and extending to a short distance only down the incline. This catches the gripping arrangement as the car slows up the incline, and hauls the car up to the platform, where it stops and discharges passengers. It is then sent off on a switchback flight, by gravity, to the next station, where it hitches to another moving cable. It is calculated that an average speed of 10 to 12 miles an hour, including stoppages, can be readily obtained. There being no travelling motors, the construction of the track is much lighter than if engines were required, and the system is said to be much cheaper than horses, steam, or electricity. It requires, of course, an elevated structure similar to the New York railways.

Whitehall Court.—The work of laying the underground cables in Whitehall-place was begun on Tuesday, and is to be finished, so far as the present cables are concerned, by Saturday. The mains are to supply the Avenue Theatre and other places in the district. Troughs are cut in the roads, and lengths of troughing, made of a composition of asphalte, 6in. square and 6ft. long, are laid end to end. These are made with four 2in. holes through their length, and junction pieces of the same material are laid under the joints, and are filled in with bitumen. Four sections of this troughing are placed side by side. The cables are not laid in the troughing as the work proceeds, but are drawn through the troughing after these are covered up. A galvanised wire is pulled through each hole at the time of laying, and when the troughing is all ready this is pulled through with a rope attached to it, and the electric cables are then drawn through by the rope. The work is being undertaken by Messrs. Callender and Co. for the Metropolitan Supply Company, who have taken over the Whitehall installation. The work of construction of this station, as is well known, has been designed and carried out by Mr. J. E. H. Gordon, for whom Messrs. Crompton and Co. have supplied parts of the electrical machinery, and not by Messrs. Crompton, as inadvertently mentioned in our last.

Treating Noxious Gases.—Hartley Fewson has patented an apparatus for rendering sewer gas harmless, by electric treatment. A box fitted with inlet and outlet pipes has glass partitions arranged so that the gas takes a zigzag course from the inlet to the outlet. Each glass partition is covered on the inlet side with tinfoil. A small platinum wire passes in front of each sheet of tinfoil, but at a short distance therefrom. A similar wire passes in front of the glass side of that plate nearest the outlet pipe. Two insulated electrical conductors are led into the box, and the platinum wire in front of the plate nearest to the inlet-pipes and the wires in front of each alternate plate are connected to the positive conductor. The remaining wires, including the one opposite the glass side of that plate nearest the outlet pipe, are connected to the negative conductor. The conductors are connected respectively to the positive and negative poles of an electric generator. The gases, in passing through the apparatus, are thus subjected to electrolysis and are decomposed, and form fresh combinations, oxygen being liberated from sewer or other noxious gases and ozone being formed at the last glass partition. The resultant gases delivered from the apparatus are passed into water, the

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oxygen vitalised by the presence of ozone, and the nitrogen rising up through the water and being discharged in a harmless state.

St. Catherine's Lighthouse.—The new electric flash light at the St. Catherine's Point Lighthouse, in the Isle of Wight, is now in full working order. Prior to the 1st of May of this year the light exhibited at this station was described in the Admiralty list of lights as fixed, dioptric, of the first order—that is, it was a steady light produced by means of a 6-wick concentric oil burner and refracting lenses, the intensity of the naked flame being equal to about 730 candles. At the present moment an electric light is being shown at St. Catherine's, the full-power intensity of which was recently stated by Captain Sydney Webb, the Deputy Master of the Trinity House, to be equal in illuminating power to rather more than 7,000,000 candles. Every half-minute—for the light now revolves—a mighty flash of five seconds' duration sweeps around the sea, and is visible at distances that seem incredible. To effect this improvement a commodious engine-room has been added to the establishment, containing three steam-engines of 12 h.p. each, and two magneto-electric machines of the De Meritens type. Two of the engines are intended to work for lighting purposes, the third engine being designed to work the fog signals. As a precaution against breakdown, everything is in duplicate, with an oil light in reserve as well. In the lantern, carbons of very large sectional area and of the fluted type are used, and the optical apparatus has sixteen sides or panels. The only other lighthouses on the coast of England at which the light is produced by means of electricity are Souter Point, on the coast of Durham, between the mouths of the Tyne and the Wear; the South Foreland, and at the Lizard, on the Cornish coast. But the St. Catherine's light is ten times more powerful than the largest of these—the one on Souter Point. It is, in fact, one of, if not, as is believed, actually the most, intensely brilliant light in existence, and one which the country as a maritime nation may certainly feel proud to see on its shores.

Electric Furnaces.—Prof. Houston continues his description of the various designs of electric furnaces which belong to history, and in the current number of the *Journal* of the Franklin Institute he describes one patented by Charles Watt in 1851, which is said to be clearly a modification of Davy's, with the improvement that it describes means for collecting the metal as evolved, and therefore to a certain extent allows of a partial continuous process. Prof. Houston believes it to be quite feasible to construct on the general line of the Watt furnace, or electrolytic bath, a continuous process for the electrical production of sodium or other volatile metal, and he describes the modifications that would be necessary for such a purpose. We quote the following paragraph from his article: "I would propose the following as a practicable plan for readily obtaining a high temperature in a limited space, by the action of electrical currents—viz., employ an inverted induction coil; send rapidly alternating currents through the primary coils of comparatively high resistance and great length, and thus induce in the secondary coils of low resistance and short length enormous currents of great heating power, such as are used in electric welding. Such currents could be employed to produce the comparatively low temperatures required in connection with the apparatus proposed above, by causing them to traverse and heat to incandescence coils of wire surrounding the space or vessel to be heated, or to produce more intense temperatures by the action of voltaic arcs that are caused to play directly on the furnace or space to be heated. They would appear to be particularly suited to such metallurgical processes where different fusions are to be effected. The device proposed would possess the advantages of being readily obtained in a limited space, and of producing the highest temperatures possible. The ease with which ordinary smelting operations could be carried on in all locations within reach of an alternating-current circuit, even on a comparatively extended scale, is evident."

Eiffel Tower Lifts.—In the *Proceedings* of the Institution of Civil Engineers an abstract is given of a paper describing the lifts to be worked by electricity at the Eiffel Tower: "Two lifts are suspended at the two ends of eight steel cables passing over a pulley, and move up and down in two cylindrical adjacent cages, being kept vertical by the aid of guides. Each lift is divided into three compartments, one over the other. The two upper compartments are designed to hold 100 passengers, and the lower compartment contains a motor of 25 to 30 h.p., to which the electricity is conveyed by a wire from generators on the ground. The motor gives a rotating motion to a truck connected axially with the bottom of the lift, which rolls, by means of four projecting wheels placed radially, along a helicoidal rail winding round the side of the cage. There are two of these helicoidal rails placed slightly further apart than the diameter of the wheels, so that the wheels roll on the top of the lower one when the lift is descending, and revolve on the bottom of the upper one during its ascent. The suspending cables are exactly counterpoised by similar cables attached to the bottom of both trucks, and rolling round two pulleys below the base of the cages. It is assumed that in practice the utmost difference between the load of the two lifts will be fifty passengers, or a weight of $3\frac{1}{5}$ tons, whereas the resistance of the system to motion is calculated at four tons, so that the lifts will not be liable to move of themselves; and, though the machines are furnished with a brake, the stopping of the dynamos will stop the lifts. The descending truck, revolving under the action of its dynamo, will draw down its lift, and draw up the other lift, which will be lightened by the action of the dynamo in the truck below it. For a speed of $1\frac{2}{3}$ foot per second, the power required when the lifts are equally loaded will be 27 h.p.; when the descending lift has the maximum excess of fifty passengers, it will be 5 h.p., and, in the reverse case, 48 h.p. Under the ordinary conditions of traction there will always be a space between the lift and its revolving truck; but if the cable broke, the lift falling freely on the connecting axle would overtake the revolving truck, and thereby arrest its rotation and prevent any further movement, thus securing the safety of the lift in the event of a fracture. A telephone will place the two men working the lifts in communication, so that they can always work in concert. The lift is to take passengers from the second to the third floor of the tower, a vertical height of 492ft., without a stoppage, in about five minutes.

Education of Electrical Engineers.—In a little handbook on "The Technical Education of Engineers," being a course of study recommended by the Manchester Association of Engineers, the following admirable remarks are made with special reference to young electrical engineers: "Electrical engineering, being not only one of the most recent, but pre-eminently a promising sphere of engineering science, possesses a peculiar charm and fascination for the aspiring youth who is fired with a noble and

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praiseworthy determination to break up new ground, for this opens up to him a fruitful field of research and labour, on which many a fierce battle has to be fought, that will yield many successful and triumphant victories to cheer and reward the enthusiastic and indefatigable student for his labour in the pursuit of this very interesting subject. The student burning with a zeal to distinguish himself in this department of practical engineering must, however, rest assured that he can only achieve distinction and success by hard study, intense application, and untiring industry in the laying of a solid foundation of theoretical and practical engineering, for on this he can safely and steadily proceed to build a superstructure that will undoubtedly prove to be both honourable and satisfactory. The young engineer who has decided to qualify himself for this charming speciality, should, in addition to securing a thorough training in the actual workshop practice of general engineering, devote himself to the comprehensive study of pure science, as this forms a very important factor in electrical engineering, and it is essential that he should give especial care and attention to the study of mathematics, magnetism and electricity, sound, light and heat, so as to gain a thorough and perfect knowledge of these subjects, while he must not fail to secure an advanced attainment in theoretical and applied mechanics and metallurgy, as well as of machine and freehand drawing; it is further requisite that he should acquire a thorough understanding of steam and chemistry, along with a practical acquaintance of the various forms of motors that may be adopted for the generation of electricity; it would also be of great advantage to him to get a fair degree of proficiency in the German and French languages. Though the course of study indicated may seem at first sight to be very severe, it is quite within the compass of, and by patient toil and indomitable pluck can be attained and mastered by the plodding and painstaking student, who then, if possible, should have—which he will have richly deserved—the benefit of not less than one year's practical work in the service of some eminent electrical engineering firm, that he may obtain a full and varied practical experience of constructural electrical work, in order to thoroughly equip and educate himself for gaining a future honourable position and assuring success in his adopted profession of an electrical engineer."

Electric Sugar.—Samples of the electric sugar have arrived in London, and were on view on Wednesday at the office of Mr. P. H. Davis, editor of the *Confectioners' Union*, 171, Queen Victoria-street, where they were inspected by a large number of gentlemen representing the Press and the sugar industries. Mr. P. H. Davis states that he knew Prof. Friend before his death, and also his father-in-law, Mr. Howard, who is now carrying on the process. He was asked to subscribe to the company, but, as Prof. Friend was dead, he refused, and now professes extreme regret, as the shares are even now at abnormal premium, and he fully believes the scheme will be a good one. A private trial was made on August 24 at the factory at Brooklyn, when 400lb. of refined white sugar in a granulated state were produced, but the machinery only worked for four minutes, owing, it was said, to a breakdown of the granulators. A public trial was arranged for September 7, and the following gentlemen were present: Mr. B. H. Howell, of the firm of B. H. Howell, Son and Co., Wall-street; Mr. Willett, of the firm of Willet and Hamlin, of this city; Mr. G. L. Montgomery, agent in New York for Messrs. Jardine, Matheson and Co., of London, England; Mr. Forwood, of the firm of Pim, Forwood and Co., of this place; Mr. John Lee, of the firm of J. Bruce Ismay, agent of the White Star Line in this city; Mr. Lawson N. Fuller; Mr. Robert Roberts, of Birmingham, England; Mr. Cotterill, the president of the company, and Mr. J. U. Robertson, secretary. Mr. Robert Roberts writes a full account to the Birmingham papers of his personal experience. He says, "The repairs being made and the machinery having been tested several times, a day was fixed, and several representative men were invited to witness the refining of 25 tons of sugar in a few hours. The raw sugar was delivered in 200 bags at the factory on Friday, August 31. The demonstration came off to-day, Friday, September 7. At the hour appointed, the invited gentlemen assembled. Mr. Cottrill addressed a few observations to the company in explanation of what was about to take place; and on the signal being given the steam was turned on. In a few minutes the spouts began to run with refined sugar in three streams, as before—two being granulated sizes and the third ungranulated refined. As fast as the barrels filled, they were removed, and empty ones put in their place. The process was to have continued till 150 barrels were filled, but the overheating of a "journal" in the machinery, and the slight warping of a shaft compelled a stoppage at the end of an hour and ten minutes. Sufficient was shown, however, to satisfy everyone of the reality and capabilities of the process. Thus is finally disposed," says Mr. Roberts, "of the persistent contention of many that the electric sugar enterprise was a sham and a delusion, and thus are for ever dispelled the fears of another class, who were inclined to suspect that, though not a fraud, the secret had died with the professor, or, at all events, could not be rendered practically operative. In a few weeks the remaining granulators (already nearly complete) will be entirely finished, and on the completion of certain pending arrangements, the factory will be ready to manufacture for the market at the full rate of its capacity of over 5,000 barrels a day. When this point is reached, it will not be long before substantial results begin to come into the hands of shareholders. It will interest everyone connected with the enterprise to know that since the demonstrations referred to in the foregoing, shares have risen to a great price, and only wait the actual running of the factory to rise to a figure twenty times what shareholders have paid. I bring with me ten barrels of the sugar refined to-day." The samples obtained by Mr. Davis were sent over specially in response to a cablegram, and arrived on Tuesday evening last. The samples of sugar shown are in small bottles, and appear of a fine white granulated nature, in various sizes of granulation, from iceing sugar to small lumps. The samples naturally caused a great deal of comment among sugar dealers in the City, one of them stating that the appearance of the granulations was such as was produced by no known process of refining. The quality of the sugar is to be reported upon by Prof. Nicholls, F.C.S., who is analysing some of the samples. A good deal of incredulity is prevalent, people not knowing how to take the seriousness of the invention, the magnitude of which, if true, will revolutionise the whole sugar trade. It is stated that for a cost of £4 the work can be done which now costs nearly £20. It is still proposed not to disclose the secret process, but to erect a gigantic concern, so it is said, which will undertake sugar refining and sell at, say, £1 per ton less than present cost, pocketing the difference—a truly American idea. There is this to be said, anyhow—if sewage can be refined, why not sugar?

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ACCUMULATOR CARS ON THE NORTH METROPOLITAN TRAMWAYS.

At the last meeting of the North Metropolitan Tramway Company it was mentioned that probably before the next meeting the shareholders would be able to see electric cars running upon one of their lines. This statement is in a fair way for fulfilment, and we have lately taken an opportunity of inspecting one of the electric cars, and of ascertaining the arrangements now in progress for the inauguration on the London tramways of a system of electrical traction. The method employed is that of cars carrying their own supply of electricity stored in accumulators, and seems to leave nothing to be desired, either in simplicity or in ease of working, and at the same time will not only save greatly in the first outlay for plant, but can be run at considerably less than the present cost with horses.

The system is being carried out, not by the tramway company themselves, but by the Electric Traction Company, Limited, of 23, New Broad-street, who have been occupied with carrying out numerous experiments with electric accumulator cars for some years. In 1887 they made some experiments with an electric car at Southwick, on the West Brighton and Shoreham Tramway, which were extremely successful, and attracted at the time a good deal of notice both of electrical engineers and of tramway directors.

Board of Trade Certificate.

Major-General Hutchinson, for the Board of Trade, gave his certificate for the running of this car, and expressed himself fully satisfied and greatly pleased with the working of the system. Various improvements in the details have been since made, and the whole system properly organised for commercial use on existing lines.

Contract with Messrs. Immisch.

The Electric Traction Company, after extended experience, consider the motors of Messrs. Immisch and Co. to be the best attainable for this purpose, and have entered into a contract with this firm to use these well-known motors in the tramcars on their system. The design of motor may be modified to meet the requirements, also the gearing and the accumulator; but having tried a number, now use the combination of chain gearing, which experience has shown them to be simplest and best. They have satisfied themselves that in their present arrangement they have a system which is practical and economical, and one which can with ease and advantage be introduced upon any tramway now existent without extra outlay, and upon new tramways with an actual saving of first cost.

North Metropolitan Tramway.

The North Metropolitan Tramway Company have been so far convinced of the practicability of the accumulator car that they have entered into a preliminary contract with the Electric Traction Company to run one entire section of their route—that of the Barking-road, extending from Canning Town to Plaistow—upon this system. Six cars are being built for the Electric Traction Company, fitted at their own expense with electro-motors, gearing, and accumulators, and they have undertaken to run the cars, including all expenses for the tramway company, at a charge of 4½d. per car-mile for a period of six months. At the end of this period the tramway company will have the option of taking over the whole system. This charge is 1½d. per car-mile less than the actual present cost of this route, the average cost of the whole lines being 5d., and of the Barking-road route 6d. per car-mile run. The route chosen is one well fitted to try the capabilities of the new cars, being a single line road, not too smooth, and having both up and down hill gradients and level running. The only objection, perhaps, is its shortness, being only one mile and a quarter long, but, of course, in such a case few cars are sufficient.

Advantages of the System.

Before describing the car it may be well to state for those to whom the subject is new that systems of electrical tractions divide themselves into three classes, two with electric conducting wires, and one with self-contained electric accumulator cells. The first system is the "parallel" system, in which two main cables (either overhead or in conduits) are charged with electricity at a moderate pressure, say 200 to 300 volts, and extending the whole distance of the line; from these conducting cables connection is made by a small rolling wheel or brush to the car. Each car thus draws from the mains whatever current it requires, as each house draws its water or its gas from the mains. This system is similar to that by which incandescent lamps are usually supplied. The motor is made into a magnet by the electricity, and forcibly rotates the armature and axle at great speed, which motion is communicated by gearing to the car wheels. This is done in the same manner whichever system is adopted. A long and exhaustive description of such a system, now successfully working at Richmond, Virginia, in America, by Frank T. Sprague, has recently been given in this journal.* The parallel system is largely in actual use in America, several hundreds of miles of tramway line being at present successfully working on this system.

The second system is the series system, in which the electricity is driven at high pressure through all the cars on the line, one after the other. This allows a much smaller wire to be used, and in many cases a single wire is sufficient. For long lines the series system will be preferable to the former. The supply of electricity is similar to that used for running arc lamps. This method of working is in use at several places in America, and is likely to extend, especially for long lines. It is in use for goods' skeps on an overheard suspension line in England, at Glynde (the telpher system), and is described by Prof. Ayrton, one of the inventors, in his paper recently read before the British Association.† Both these systems require special conducting wires.

The third system, which is the one adopted by the Electric Traction Company, is that of self-contained cars, each car carrying its own store of electricity in a set of accumulators. The advantages of this system are evident for many situations, and it is likely to prove the most useful on English tramway lines for two reasons, firstly; because in this country it will be impossible to line the city streets with poles strung with electric wires; and, secondly, because it requires no great immediate outlay, nor extensive change of plant. The accumulator cars, being self-contained, and requiring no alteration of the tram-line itself, can take their places gradually among the horse-drawn cars, and the alteration of the method of traction can be introduced as the old horse-cars wear out. The cost of an accumulator car is no more than the cost of an ordinary car with its complement of, say, ten horses, and the incidental expenses are less. Any tram-line can thus, on satisfying itself of the practicability of the system, order a few cars to start, put up a charging station, and gradually extend as the old cars require renewing. This fact alone will serve greatly to induce tramway companies to adopt it, while the ease and simplicity of working, and the fact that each car is entirely independent of the rest, will assuredly tell heavily in its favour.

Each of these systems will have its place according to the various necessities and requirements. For short lines, or those running in a circle, where conducting lines would not be objectionable, as, for instance, in a subway or underground circuit, the parallel system will have its place. For long lines where a few cars make long journeys, for overhead goods' traction, and, probably, in time for railway passenger traffic, the series system will prove to be the best. While for ordinary city and suburban tramways, and for electric omnibuses and separate railway delivery vans, the accumulator system, which dispenses with cables and allows each car to act as a unit, will probably be far the most preferable in every respect. Accumulator cells have been now brought to such perfection that responsible firms will contract to keep them in working order for 10 or 12 per cent. of the first cost, and there is every reason to believe that they will be perfectly successful for this purpose.

* *Electrical Engineer*, August 3, 10, and 17, 1888.
† *Electrical Engineer*, Sept. 14 and present issue.

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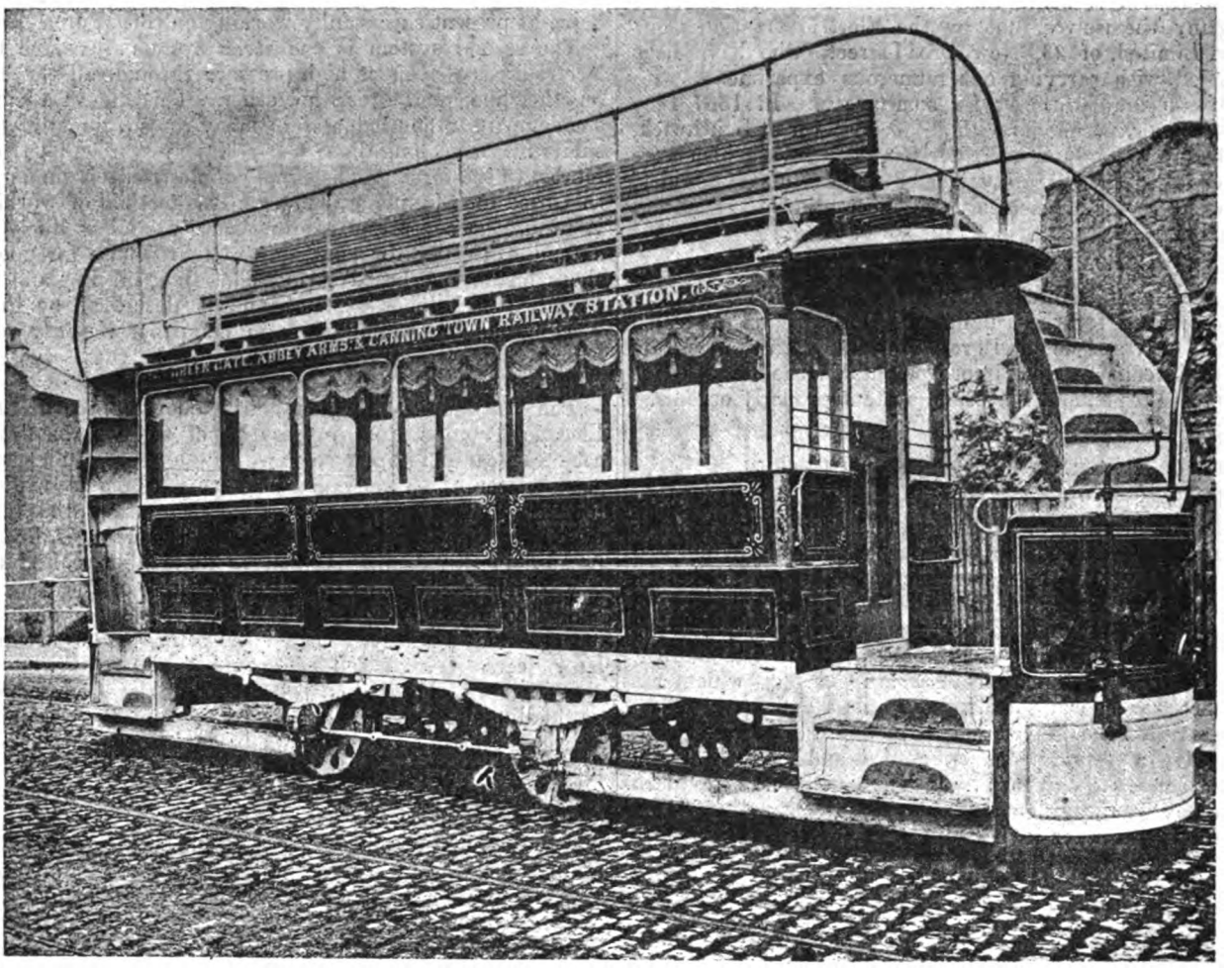
Description of the Car.

The appearance of the car now running upon the Barking-road is shown in the accompanying illustration. It is a handsomely-finished car suitable for the best lines of tramways; the six new cars now in course of construction for this road being for an East-end suburb, with a penny fare and mostly used by workmen, will be less expensively fitted, and will be very similar to those at present in use. In all essential particulars, however, the cars are the same, and the technical description equally applies to both. In appearance the electric car is in no way noticeably different to an ordinary car, except that it is a little higher, and, of course, has no horses. The car is entirely self-contained, and has a complete and finished appearance; but the sight of a tramcar briskly proceeding along without ostensible means of traction is at first an object of curiosity to those who have never before seen an electric car. The horses, too, are occasionally restive, but very soon get used to it.



Accumulator Car of the Electric Traction Company.

The accumulator electric car consists essentially of four parts, namely, the car body, the set of accumulators, the electric motor, and the gearing. The ordinary car body is raised a distance of 7½in. higher than the ordinary car, this being the amount the car wheels usually project underneath the seats. The whole space beneath the seats is thus available for the accumulator cells. The sides of the car are divided into panels, which let down upon the outside and allow the accumulators to be taken out when exhausted and replaced by those ready charged. The accumulator cells are firmly mounted upon wooden trays to allow of easily manipulation in changing. Each cell is double, and each tray contains four double cells. There are six trays on each side of the car, thus making a total of 96 cells, giving an available E.M.F. of 192 volts in series, or, if grouped in two sets parallel, of 96 volts.

The motor used is an "Immisch" motor, 7in. armature, specially constructed for the work. It is slung on a hanging frame bolted to the car beams, with an adjusting screw to tighten the chain if necessary. The power of the motor may be said to be about 6 h.p., but it is difficult accurately to express this, varying, as it does, according to the current required, from 1 h.p. up to as much as 10 h.p. The average current required is about 35 amperes, which, with the ordinary method of connection of cells, two sets in parallel, at 96 volts, gives $35 \times 96 = 3{,}360$ watts, dividing by 746 watts to the horse-power, this will be 4½ h.p. On an incline 70 amperes will be used, which approaches the limit of 10 h.p. The motor runs usually at about 1,000 revolutions per minute.

The gearing by which the motive power is transmitted to the wheels consists of a double set of chain gearing. The motor itself is fitted with a sprocket wheel on its axle, and is connected with a Reynolds' steel chain to a large toothed wheel on a countershaft beneath the car: this has a similar small toothed wheel, geared by a second chain to a second toothed wheel upon the axle of the car wheels. The ratio of motor revolutions to those of the car wheels is ten to one. The chain gearing is similar to that used for driving the electric dog-cart (*see* our issue of Sept. 14, p. 215), but this is single gearing only. By the double gearing the motor wheel is enabled to be of a larger size, and is not so liable to slip. This method does without expensive castings, and is as simple and convenient as can be wished. There is very little back-lash, and the car starts off without jerking.

The driving arrangements are also excessively simple, nothing being seen but a key-hole in the back of one of the steps, and the ordinary lever crank tramway break. The driver has a crank handle, which is inserted into the key-hole, and regulates the switch, and this crank can be taken away when the car is not in action; there is, therefore, no danger by accidental knocks or from tampering with the switch. The conducting cables from the cells are led to this switch, and a set of three resistance coils fixed on a fireproof frame beneath the car are also connected to the switch. The motor can be connected with the cells in parallel by one movement of the handle, and with the whole of the cells in series by an opposite movement. The

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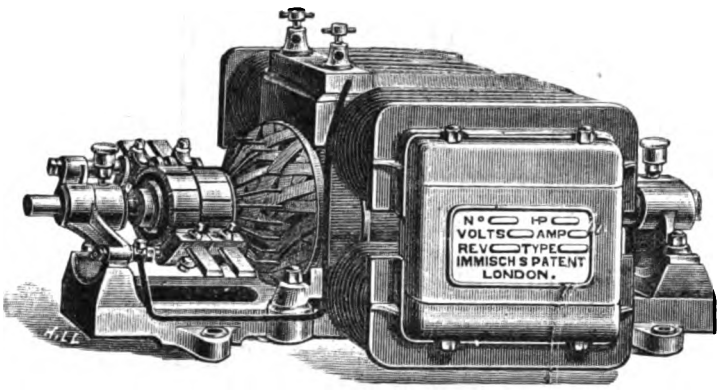
current passes first through the resistances on starting to prevent excessive sparking at the brushes. Besides the regulating switch, there is a make-and-break switch in the circuit to entirely disconnect the cells when not in use. A reversing lever is also attached to the brushes, by which the direction of the car is at once changed. These arrangements are the same at both ends of the car.

The total weight of the car without passengers is five tons; the car itself is 65cwt., the accumulators weigh 30cwt., and the motor about 5cwt. The accumulators used in previous trials have been Tatham cells, but the cells used in the new cars for the North Metropolitan Tramway Company are a specially made type of the Electrical Power Storage Company for tramway work. It was at first thought necessary to provide special splash-boards to prevent the battery solution from spilling, but experience has shown that this precaution is unnecessary, a slight ripple being all that is noticed when the car is in motion. The seats are removable, and inspection of the cells is perfectly easy. There is no smell or fumes.

The running of the car, as exhibited last week, was extremely easy and regular. It started off gradually with a single turn of the switch, could be accelerated or slowed, stopped and reversed with simple movements of the switch and break-handle. The ordinary car drivers have not the slightest difficulty in taking the car in charge, and from their remarks look upon its innovation with favour. The ordinary pace at half speed is more than equal to that of the horse cars; it will easily run seven or eight miles an hour, and at full speed will run fifteen or even twenty



Immisch Motor used in the Electric Car.

miles an hour. A trial was made of its carrying capacity a short while ago, when the car was loaded with twenty men and eighty boys. Under these conditions it made good speed the whole length of the line. On its return it took twenty men and one hundred boys, a load fully equal to three times its usual complement, and had no difficulty in carrying this number. The cars, of course, are heavier than the ordinary car by the weight of the accumulators, motor, and gearing, but no change is necessary in the shape of the tram-rails, and no special change is required in the points, which have only to be kept in fairly good condition for the car to take the points easily and automatically. It must be also mentioned that each car is fitted with two incandescent lamps each, with their own switch fed from the accumulators for lighting the cars at night.

Method of Changing Accumulators.

The greatest trouble likely to arise in the accumulator car system is that of charging and changing the sets of accumulators. This has been reduced to the utmost simplicity of manipulation by the arrangement devised by the company's engineer, Mr. Thomas Frazer. The cells, as already mentioned, are mounted upon trays, six to each side of the car, these trays are each fitted with projecting connecting pieces, two on each tray, which rest upon two stout laminated springs fastened to the car frame. The two contiguous springs are connected together, and electrical contact is thus automatically made throughout the car by simply running the trays into their places. At the charging station wooden benches are arranged upon each side of the tram line, of the same height as the floor of the car, and fitted with similar spring contacts. When the car comes into the station its panels are swung down, and it is run between the benches; the trays are pulled out upon the benches, automatically making contact with the charging circuit, which is led by copper cable from the dynamo-room, and as the last tray is pulled out the cells begin to charge. The car is then run along to the next bench, where another set of cells has been charging. These are pushed into the car, which is then ready again to depart. This operation is performed by unskilled labour, and takes no more time than changing horses.

Charging the Accumulators.

The charging arrangements at present adopted at Barking-road comprise a portable Davey-Paxman 8-h.p. steam-engine, driving an Immisch dynamo, which gives 40 amperes and 250 volts at 600 revolutions. The cables are led to the two main bars of a distributing switch, having levers to supply twelve sets of accumulators, if necessary. From these, cables are led along the roof into the car-shed, dropping down to the charging benches. Two sets are at present used, and the installation will shortly be increased to supply the six cars required to work the whole of the line. Two 40-h.p. steam-engines will be permanently fixed with their corresponding dynamos, and either set will be capable of supplying the whole of the cars.

The time taken in charging is about eight or nine hours, and when charged the accumulators contain enough energy to run the car a distance of thirty-six miles. A full day's run may be taken at about fifty to sixty miles, so that the electric car can easily do half-a-day's work with one charge. To prove that the power in the accumulators will remain practically without leakage for a considerable time, the following test has been made. A car was charged on the first day of a month, and run for twelve miles, and was then left until the 18th day of the same month, when it was again run for twelve miles, and on the last day of the month the last dozen miles was taken out of it without any recharging, giving fair proof that the cells do not suffer to any appreciable extent by leakage. This point is of great advantage over horses, as, of course, upon slack days, no energy—the equivalent to horse-feed—is being consumed uselessly, a less number of cars could be run out, and those not in action would be causing no actual expense.

Economy of the System.

The direct economy of the system over that of horses is, of course, the most important feature of the electric system of traction, the power from coal being used instead of that from hay and oats. If it can be proved that a direct saving in expenses of one penny per car mile can be effected, this in itself will be a most powerful inducement to tramway directors to introduce the system with the least delay. The Electric Traction Company are willing to undertake the contract of running of the cars for the tramway company at a price 1½d. less than that which it now costs, and, if they can make a profit, the tramway company themselves can be relied to run the cars at the same or less cost to themselves. The importance of the saving of one penny per car mile may be estimated when it is mentioned that the North Metropolitan Tramways of London alone ran, according to the Board of Trade returns for the year ending June, 1886, the enormous mileage of 5,927,451 miles. A saving of a penny per mile on this amount would realise no less than £24,697 per annum, available for increased dividends or extension and improvement of the service. It must also be remembered that improved methods and the dropping in of patents will tend to reduce the expense of the electrical system, while the cost of horses and fodder being now very low, may most probably tend to increase the expense for horse cars. The saving in scavenging, in wear and tear of the track, possibly the entire absence for necessity of centre paving, are additional advantages of the system.

Saving in Land and Buildings.

The advantages that the accumulator system offers for English tramways are not dependent alone upon its direct economy. The saving in outlay of capital for land and buildings is another most important item. When it is recollected that very often for the full complement of a horse car, ten horses are required, it will be seen that for

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a large company taking, say, 100 cars, there will be required 1,000 horses. The stabling for these must be on the ground floor, and the outlay for purchase of land and erection of stabling is one of the most serious items, especially in large towns such as London, that a tramway company has to face. This will nearly all be saved in the electric system; for except the engine-house, and certain additional space in the car houses for the charging benches, none of these buildings will be required.

Cost of the Cars.

The Electric Traction Company not having yet established their factory upon any scale commensurate with undertaking large contracts, it is, of course, hardly possible to furnish the exact cost of the electric cars, but it may be taken that the total cost will equal that of an ordinary car with a complement of ten horses at £30 to £40 each. The first outlay for car and motive power will in either case be about the same.

With the factory in full working order the probable time for delivery of a fully equipped electric car would be well within three months—say, ten or eleven weeks. Ordinary cars could be converted and fully fitted within one month. To alter the ordinary car the body would be lifted and placed upon two side beams, with hinged side panels for entrance of the accumulators; strengthening pieces would be put in, and the motor and gearing fixed. The actual cost of altering the ordinary car body would probably be about twenty to forty pounds, and the special car without electric apparatus would be about the same amount extra to the usual cost of a car—the price of an ordinary car being about £200.

We have here attempted to give practical details of the accumulator electric tramcar system in such a manner as shall commend itself to practical men. We believe that the day is immediately upon us when, in such hands as those of the Electric Traction Company, under the chairmanship of Viscount Bury, and in conjunction with such firms as the Electrical Power Storage Company and Messrs. Immisch and Co., the introduction of electricity as a motive power for our suburban tram lines will become general, undertaken, as it can be, without great initial outlay, with considerable direct saving of expense, as well as much indirect economy, and with a greatly diminished outlay for new lines or for the extension of old ones.

LEAVES FROM THE DIARY OF A YOUNG ELECTRICIAN.

BY BROAD BENT.

(Continued from page 178.)

May 9.—I left my diary somewhat abruptly last evening to attend to five lights at S. M. I found that they were all on one circuit, so I naturally looked for a common cause of failure. This I found to be the fusion of a safety-plug.

It is a curious fact that although a lead wire carries a certain current when first put up, it will in course of time fuse with the same current. Thus the plug I put in last night is constructed to carry the same current that the old one melted with.

May 10.—A new engine-driver starts to-day. I hope he will not turn out so merry as the last. He certainly looks quieter and seems to know his work well, but I must not be too sanguine till I have seen more of him, as I thought the last man very good till I found him mad.

May 15.—C. S. sent up yesterday, just after I had been down there. It was the usual vague message, "Electric 'ight man wanted." "Well, what's the matter, now?" I asked, when I arrived there." "Oh, we want a new switch here; we are afraid of this catching fire." "It looks all right to me, and is quite cool," I answered. "What makes you think that it will catch fire?" The man I was addressing then turned off the switch very slowly, so that a small arc appeared just as the contact pieces separated, and he kept it in this position until the wood base began to smoke, and then looked up with an air of satisfaction. I, of course, explained to him that a switch was not intended for a plaything, but to turn lights off and on when required; and further, that if the switch ever caught fire, I should report that it had been done wilfully.

June 2.—There is a low resistance "earth" on one of the conductors. By connecting one terminal of a lamp to the earth wire, and the other to one of the conductors, almost as good a light is obtained as by connecting the lamp across the terminals of the dynamos. Doubtless, there are several ways of localising this fault, if one proceeds on the lines indicated in the various text-books; but, unfortunately, in practice, circumstances prevent the adoption of such cut-and-dried, beautiful-in-print methods. The course I intend to adopt will, I imagine, be worthy rather of an amateur than an incipient electrician. However, as I cannot manufacture circumstances to suit any particular method of localisation, I must adopt a course that will be applicable to existing arrangements.

June 3.—All last night was taken up in searching for the fault (localising the "earth" sounds better, but, considering the means employed, I have not the impudence to use that expression). First of all it was necessary to find out on which side of the shed the fault existed. To do this, I had the engine run at about half-speed—that is, at a speed sufficient to redden the lamps. I then connected a test lamp from one terminal of the machines to earth, and by disconnecting the cables one by one from the terminal board, found out on which side the fault lay. The test lamp went out when cable B was disconnected (see Fig. 5), which indicated that the leak to earth was on the S. M.

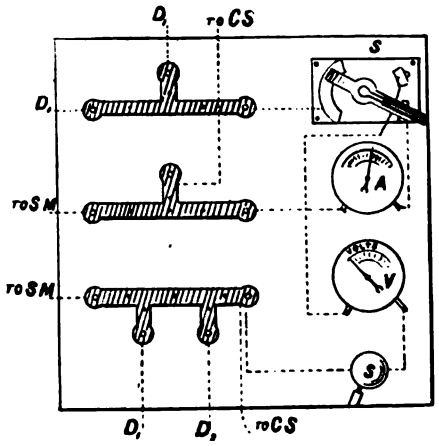

FIG. 5.

D_1 D_1 Cables to Dynamo I. D_2 D_2 Cables to Dynamo II. S M Cables to Station S M. C S Cables to Station C S. V Voltmeter. A Ammeter. S Switches.

side. The next question to be answered was, "At which station on the S. M. side does the fault occur?" I therefore provided myself with what tools I considered necessary, including the test lamp, and told the engine-driver to keep the engine at about that speed till I returned. He, however, expressed a wish to go with me, saying the engine would be all right for an hour or so. We therefore walked together through the tunnels till we reached O. R. station, which is not a quarter of a mile distant from the shed. Having found a step ladder, after much searching in the feeble light given by the lamps, I mounted to the terminal box from which the principal circuits are taken (see Fig. 6). I then connected one terminal of the test lamp to an iron girder on the bridge, and the other to one of the conductors, thus completing the circuit through the lamp to earth. On taking out the plug, *p*, which carried the current to all the lamps on the station, the test lamp also went out. I was glad of that, for it saved a journey to S.M. It was then necessary to find out on which circuit the earth-connection occurred, so having again inserted the plug, I began to disconnect one by one the circuits, *a*, *b*, *c*, and *d*. On disconnecting *c* the test lamp indicated that was the offending circuit, by going out. From my position on the top of the ladder I called to Brown (the engine-driver), and handing him down the hand-lamp told him to find out where circuit *c* led to. In a few minutes Brown returned and informed me that the wires terminated in the street lamp, but that several circuits branched off from them at intermediate points.

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Again, connecting up circuit *c*, we disconnected the various branch circuits, noticing at each disconnection if the test lamp remained alight, which it did until we reached the street lamp, but on disconnecting the latter it went out. To make sure that we had at last arrived at the source of leakage we re-made every connection except that of the street lamp, which was accomplished without producing any current in the test lamp, but on connecting up the street-lamp, the test lamp was re-lit. It now remained to make an inspection of the street lamp. This lamp is of the ordinary street corner type, containing three gas jets; around the top of it a rim of ornamental iron work is fixed. A pair of insulated wires is carried along the iron bracket which supports the lamp, being bound to it by thin iron binding wire. They are then pulled round several sharp edges of the ornamental iron rim, and, finally, through a small hole to the inside of the the lamp, where two incandescent lamps are fixed.

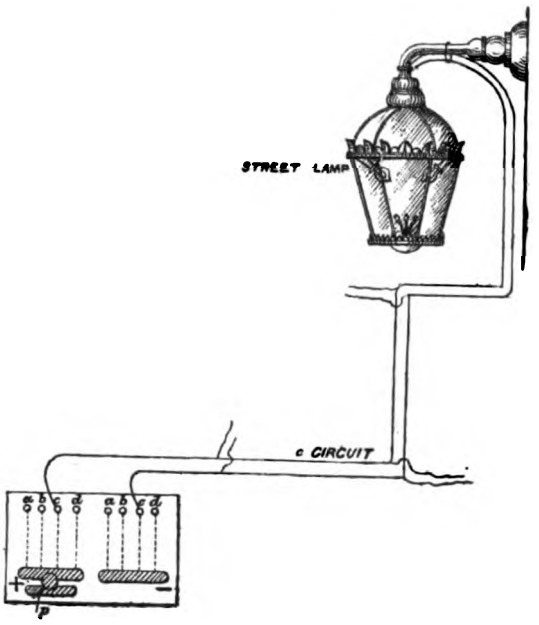

FIG. 6.—Terminal Box at O R. (Dotted lines are safety catches.)

Under the circumstances, it would have been little short of a marvel had there not been a leak to earth. It is not difficult to believe that in places the insulation is scraped from the copper by the sharp angles of the iron, thus placing the two metals in contact. This is what had happened. There was not time last night, neither would it have been convenient to run these wires afresh, so we simply left them disconnected till a more opportune season.

June 8.—The wires in connection with the street lamp at O.R. have been rearranged, so as to completely insulate them from the iron work. This was accomplished by slipping over them, at short distances from each other, a number of hard wood tubes, about an inch long; these are then bound to the bracket, thus holding the wires a little way from it. A small block of wood is also inserted, at each sharp angle, between the iron work and the insulation of the wire.

July 6.—The usual orthodox message, "*Send the electric light man here at once*," was received from M. A. station yesterday. On going down there, I found that seven lamps which were not required in the day time refused to be turned out. One switch controlled (or should have controlled) the lot, but whether "off" or "on" the lamps remained alight. It took me a considerable time to find the cause of this, as the wires leading to and from the switch were nowhere in contact, and the lamps remained alight even when the wire leading from the main was disconnected. The cause was as follows: On the platform are two circuits, through one of which the current is always passing; the other, the one at fault, is provided with a switch. The conductors, after leaving the mains are suspended over the platforms, the wires of one circuit being bound to those of the other by tape. By some cause, which I cannot explain to myself with any degree of satisfaction, the insulation of two of the adjacent wires had perished underneath the tape which bound them together, and so placed the two wires in contact—thus converting the two circuits into one.

(*To be continued.*)

ON THE C.G.S. AND PRACTICAL UNITS OF MEASUREMENTS.*

BY W. H. PREECE, F.R.S.

In the C.G.S. system, which may now be considered to be in universal use, the quantity of heat which will raise one gramme of pure water one degree centigrade from the standard temperature, 4deg., is the C.G.S. thermal unit, and is frequently called the *calorie*, but the term calorie is just as frequently applied to the kilogramme water degree. Its mechanical equivalent is 42,000,000 ergs. Since heat is a generic term applied to that form of work which is expended on any substance when its temperature is raised, it seems desirable that the thermal unit and the unit of work should be more closely allied.

The Watt has been universally accepted as the unit of power; it is the unit rate of doing work, it is 10^7 ergs done per second. Now, Sir W. Siemens, at Southampton, 1884, proposed to call 10^7 ergs a Joule. Hence a watt, or the work done by a coulomb, or by an ampere flowing for one second, is a *joule per second*, and there would be 4·2 joules in one calorie. Thus, ·2381 gramme of water raised one degree, or one gramme of water raised ·2381deg., would equal one joule. We cannot, unfortunately, avoid the use of a co-efficient. The arbitrary character of the degrees of temperature prevent this, but the relations between the quantities are very simple.

One joule	$= 10^7$ ergs	= ·24 calorie.
One watt	= 1 joule per sec.	= ·24 calorie per sec.
One calorie	= 4·2 joules	= 42,000,000 ergs.
One British thermal unit (pound water degree Fahr.)	= 1,058 joules	= 252 calories.

Let us take a glow-lamp having the following elements:

C.G.S. Units.	Practical Units.
E.M.F. $= 100 \times 10^8$	100 volts.
R. $= 200 \times 10^9$	200 ohms.
C $= \cdot5 \times 10^{-1}$	·5 amperes.
EC $= 50 \times 10^7$	50 watts.
Candle Power.	20 candles.

$$H = \frac{C^2R}{J} = \frac{\cdot0025 \times 200 \times 10^9}{4\cdot2 \times 107} = 12 \text{ calories.}$$

Thus, 50 watts develop 12 calories per sec.
4·2 watts develop 1 calorie ,,
1 calorie per sec. develops 1·7 candles.

It is quite clear that the acceptance of the joule will facilitate many calculations and prevent much confusion.

While on this question, it is well to point out the extreme inconvenience that is rapidly increasing, owing to the incessant necessity for using C.G.S. units in magnetic questions, in having the ampere and the C.G.S. unit current different. This is the consequence of having accepted the volt as equal to 10^8 instead of 10^9 C.G.S. units. The result is that the ampere is $\frac{1}{10}$th of the C.G.S. unit current. The only reason ever given in favour of the accepted volt is that it is very nearly the E.M.F. of a Daniell cell. This was a good reason twenty-five years ago, when telegraphy was the principal practical application of electricity, but now, when we are rapidly extending the application of electricity in all directions, when we are using higher multiples of volts every year, the time has come when we should seriously consider the advisability of making the volt 10^9 instead of 10^8 *C.G.S. units of E.M.F.*, and so make the ampere and the C.G.S. unit of current the same.

Again, it is perfectly clear that 106 centimetres of mercury at 0 deg.C, 1 square millimetre in section, is only a very rough approximation to the true ohm, and that 106·3 would be a much closer approximation, and be very near the truth. The roughness of the approximation of the legal ohm has prevented its general acceptance, and there will be no universal acceptance of one and the same unit of resistance until we agree on the value of the true ohm. The legal ohm was accepted in 1883 provisionally for ten years. There will be a congress of electricians in Paris next year, and if we English electricians proceed there armed with the opinions of the British Association Committee that 106·3 can, in their opinion, more nearly represent the true ohm, and that the volt should be made equal to 10^8deg. C.G.S. units of E.M.F., it would have very great weight in the final determination. It is most desirable, also, that we establish and name unit magnetic field, but whether this is to be based on the C.G.S. units, or on the practical units, must remain open for consideration and discussion.

There is one other point to which I wish to direct the attention of the committee. It is the value of the standard of pure copper. We have hitherto accepted implicitly Matthiessen's standard. According to his experiments, the specific resistance of a cubic centimetre of pure copper at 0deg. C. is 1,642 C.G.S. units, but this is known to be about three per cent. wrong, and it is most desirable that experiments should be made to determine the proper figure The resources of the Cavendish Laboratory, where so much good work has been done, might be devoted to this desirable work. I recommend:

1. That the practical unit work, 10^7 ergs, be called the joule.
2. That experiments be made to determine the specific resistance of pure copper.

N.B.—The committee choose the term *therm* instead of *calorie* for the thermal unit.

* Paper read before the British Association at Bath.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. Graves, Esq., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. Wollaston, M.D., F.R.S., *and on April 20th we gave that of* Sir Humphry Davy, F.R.S., *whose fame as an electrician is still more prominent than that of* Wollaston. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* Prof. D. E. Hughes, F.R.S.

OPENING THE SCHOOLS.

October is the month which sees our educational establishments, whether known by the title of school or college, in full swing after the long vacation. Subsidiary to these in one sense, but far more important in another, are the scientific societies whose meetings commence about now for the winter session. The functions of the two classes of institutions are quite different, the former confining itself almost entirely to principles, the latter dealing more particularly with practice. A number of the newly-founded colleges and schools, however, attempt to form a connecting link between pure scholasticism and practice. How far they succeed is another matter, and involves the consideration of questions we are not likely to attempt. Some few years ago Prof. S. Thompson was a great advocate of apprenticeship, but we fear his connection with Bristol and subsequently with the City and Guilds Institute has led him in a great measure to abandon this advocacy. There is nothing in school, college, or society that can stand in the place of apprenticeship. Too many fond fathers and mothers, believing in white hands and clean shirt fronts, fancy their sons will achieve fame and success as manufacturers or business men without going through the mill of manual labour. The cramming of book lore and formulæ, the tinkering about with pieces of wire and electric apparatus is supposed to fit a man for the everyday work of the electrical world. Well, it may if he turns promoter or director of companies, otherwise he lives upon his friends, for he can never earn his own living. Rather we might put it, to labour, in the strictest sense of the term, he is ashamed, because of his bringing up—but to beg he is not ashamed. Now we are not far from the mark in saying that nineteen-twentieths of the lore of ordinary text-books is so much rubbish that the student has to unlearn in practice, and he will find the old saying quite true, an ounce of experience is worth a pound of theory. The progress of to-day in matters electrical has not come from, has not even been indicated by, the scholastic mind. In saying this we claim the Brothers Hopkinson to be outside scholasticism altogether, just as Mr. Preece claimed Sir W. Thomson among the engineers rather than the mathematicians.

Unfortunately, our schools at the present day are dominated by that curse of modern education, excessive examination, and instead of the pupil gaining a thorough mastery over general principles, he wastes his time upon historical and antiquated rubbish, a knowledge of which, however, probably brings a good lot of marks at the exam. When therefore the pupil is brought into contact with those who apply principles he is in a new world, and has to commence learning again. If he goes from school to a technical college, he is similarly situated, and thus perhaps we ought to lay the whole

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blame upon the ordinary scholastic curriculum of the day. In actual business there is little room for the pure electrician, but there is plenty of room and opportunity for the electrical engineer. The outlook at present, putting aside the work in manufacturing concerns, is that just as a gas manager is required at every gas works, so an electrical engineer as superintendent or manager will be required at every large central station. He must be a practical man and know his business thoroughly from beginning to end. These positions will be the plums of the profession. Below the managers there will come two or three classes of electrical engineers. In a large installation one may take charge of the testing, one of the repairs to circuits, another of repairs to apparatus, and so on. Still further down the scale we come to the linemen, the gangers, and the labourers. Neither school nor college will do much for any of these men unless the information obtained therein be supplemented by apprenticeship. Formerly it was all apprenticeship, now we have rushed to the other extreme and have none. Probably the best education would be half-and-half. Each of the technical colleges could easily act in conjunction with a number of engineering firms. If they did so, there ought to be little or no difficulty in modifying the present conditions so as to get something of a practical character in lieu of apprenticeship. Suppose, for example, the class limited to sixty, and these sixty students divided amongst a dozen engineering firms, each student could work in the shop, say 34 out of the 54 working hours of the week, and at the end of twelve months he would be a better man than if he had devoted himself wholly to the class or to the shop. It may be argued that the laboratory teaching is the equivalent to the shop, but all the argument in the world will not convince us that this is the case. Great credit must be given to Mr. Hammond, who, in earlier days, tried to organise a "college" in connection with his works. The idea was excellent, but, for various reasons it is not necessary to dwell upon, it ended in failure. The larger firms, such as Crompton Co., the Brush Co., Woodhouse and Rawson, &c., take pupils, but so far as we know, there is no theoretical course in connection with the work of these pupils. Mr. Crompton once, we believe, arranged a course of lectures by Prof. Fleming, but these are isolated cases, and not, as we would have them, regular things. Surely, the premiums paid are sufficiently good to enable such organisation as we have hinted at being carried out; if not, we feel convinced that parents would prefer to pay a somewhat higher premium to obtain the advantages of such a system. It is necessary to caution parents as to where they should send their sons. Some people who have but the faintest right to call themselves electrical engineers hope to obtain most of the capital required in a hole-and-corner business by taking pupils. Shun these people as his satanic majesty proverbially shuns holy water. It is better to pay more to a firm of repute than to go in for the cheapest. The remarks we have made are directed towards the requirements of a particular section of workers. No doubt a fairly good case can be made out for schools and colleges under the present system. Some of them are doing good work, though they might do better; others are practically useless, and the money and time spent therein is lost. It is not the ready pen that pitchforks a man into a position of trust and responsibilty so much as ready fingers, and a capacity to be on time when difficulties arise.

CORRESPONDENCE.

CROMPTON'S LARGE DYNAMO.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—As Mr. Crompton is abroad somewhere, and I was jointly responsible for the design of this machine, it may be best for me to answer Mr. Eaves's letter. The radial depth of the armature core is large in proportion to the rest of the machine; it is, if I remember right, 5½in. It may be small relatively to the output, but our practice is to take a very large output from a drum armature of given size. There is no enormous mass of solid metal in a strong field in the centre of the armature. The shaft is very strong, and has a very unusually large factor of safety; but careful calculations were made to make sure that there would be no heating there, and there is not any. It has always been Mr. Crompton's practice to make his machines as strong as possible mechanically, and I quite agree with him, and think, considering the enormous strain the armature is sometimes subjected to, that the shaft is well designed.

Oddly enough, the series winding was adopted after the most careful consideration, as being best suited to withstand the effects of the large variations of current. Mr. Eaves's theory would have been quite right in the case of a small machine of Crompton's usual type, but in this case it does not quite hold. The theory of this would occupy too much space, but as Mr. Crompton and I are writing a joint paper on large dynamos I hope we shall be able to discuss these matters with Mr. Eaves later on.

It is quite possible that if Messrs. Crompton get an order for another machine, an alternator will be made; but the Cowles Company preferred a direct current because they had used one before. An alternator for such a purpose must be specially designed, as it must not pull up if short-circuited, as it would be rope driven, with an enormous fly-wheel behind it.

In any case a fan would be used. It is cheaper to get rid of a certain amount of heat by a fan, than by increasing the size of the machine till the ventilating surface is large enough to carry it off.—Yours, &c.,

JAS. SWINBURNE.

ELECTRIC HYPOTHESES.*

BY MAGNUS MACLEAN, M.A., F.R.S.E.

When I first realised the fact that I had to give an address to this society, I at once thought that I would endeavour to give a brief sketch of the more recent discoveries in the field of Physics. Such an undertaking requires long and laborious reading, culling from every available source; and, as the time as my disposal for this purpose was too limited, I relinquished that idea; relinquished it for this address at any rate, though I have hopes of taking it up at some future time. My present subject was suggested to me by a remark I met in one of Franklin's letters. He is discuss-

* Extracts from President's opening address to the Physical Society of Glasgow University, Sept. 14, 1888.

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ing some explanations he has given of the power and operations of points, and remarks that while they first floated in his mind, they appeared perfectly satisfactory; "but now," says he, "I have written them, and considered them more closely in black and white, I must own I have some doubts about them; yet, as I have at present nothing better to offer in their stead, I do not cross them out; for even a bad solution read, and its faults discovered, has often given rise to a good one in the mind of an ingenious reader." Thus let me hope, as I summarise the various hypotheses put forward from time to time, one or other of you may be able to see the defect of each one, and, best of all, be able to offer the true explanation of electric phenomena, so that each and all of us may have no more difficulty in answering the question, What is electricity? than we have in answering the questions, What is heat? What is sound? &c., &c.

The question, What is electricity, has been asked by everyone who has studied electric phenomena for the last three centuries, and up to the present time no satisfactory answer has been given to it. I say three centuries, for Dr. Gilbert, of Colchester, who lived between the years 1540 and 1603, may be regarded as the founder of the science of electricity. However, the number of phenomena was so limited that not till the latter part of the first half of the seventeenth century do we find experimenters and philosophers putting forward theories and hypotheses to explain them. In a sense we have only the natural history stage of electricity yet, but up to 1733 it was the natural history stage proper. New phenomena were observed and recorded, but no attempt at explanation was given. Such illustrious names as Boyle, Otto von Guericke, Newton, Hawksbee, and Stephen Grey meet us as adding new facts from time to time, but no hypothesis is distinctly stated by any of them. As far as I can interpret the electric history of this time, Du-Fay, a Frenchman, and superintendent of the Royal Botanic Gardens, was the first to formulate an electric hypothesis. His hypothesis is identical, as far as it goes, with that put forward twenty-six years later by an Englishman, Symmer; and, as I have had access to Symmer's papers to the Royal Society, and as on that account I am able to give you a summary of his views, I shall not stay to examine Du-Fay's views. Du-Fay's experiments excited great enthusiasm in Germany and France, and immediately thereafter the Leyden phial was, as you know, accidentally invented. During these years, however, no other theory was propounded, nor was there any attempt made either to refute or substantiate Du-Fay's hypothesis. Two years after (about the year 1747) Franklin, in America, and Dr. Watson, in England, contemporaneously promulgated the one fluid theory of electricity; but, as the former followed up his hypothesis by some beautiful and extensive researches, communicated in a series of letters to Mr. P. Collinson, of London, F.R.S., the theory is generally known as the Franklinian theory. Franklin calls it electrical matter, and says that it is so subtile as to permeate all common matter with extreme ease. Its particles mutually repel each other, and strongly attract the particles of other matter. Thus Franklin's electrical matter has three properties:

(1) Extreme subtilty.
(2) Mutual repulsion of its own particles.
(3) Strong attraction between its particles and the particles of all other matter.

Common* matter in its ordinary state has as much of the electrical matter in it as it can hold. The electrical particles arrange themselves in triangles, their size and shape being determined by the mutual repulsions and strong attractions of 2 and 3 above.

If you take a piece of common matter and add electrical matter to it, it will not penetrate into the body, but diffuse itself over the body, making what Franklin called an electrical atmosphere. Such a body has more than its ordinary share of electrical matter, and is said to be positively electrified. Again, if you take some of the electrical matter out of common matter, the triangles expand by mutual repulsion, and what is left still occupies the whole of the common matter; but as it has less than its ordinary quantity, it is said to be negatively electrified. The terms positive and negative are still retained in electrical nomenclature, though used in a somewhat different sense from what Franklin used them.

Again, different kinds of common matter attract the electrical matter with greater or less force. Glass, for example, has a very strong attraction for the electrical matter, and on that account it is called an electric *per se*. These are the main points in the one fluid hypothesis of Franklin. It remains to say a word or two on how the theory explained the facts of electricity such as excitation, induction, attraction, and repulsion. In the case of excitation by friction or rubbing two pieces of common matter against one another, the one piece attracted the electric matter more than the other, and hence took some of the electrical matter out of the other, thus becoming positively charged itself and leaving the other body negatively charged. Induction is similarly easily explained on the one fluid hypothesis, and so is attraction as being a direct consequence of induction. The great difficulty came in in explaining the repulsion of two bodies both negatively electrified. Remember that common matter attracts the electrical matter, and in two negatively electrified bodies we have a greater attraction between the common matters and the electrical matters than we have repulsion between the electrical matters, and hence two negatively electrified bodies ought to be attracted, according to the theory. The Franklinians first explained this phenomenon by saying that the surrounding medium had more of the fluid, and was, therefore, more attracted, and hence the two negatively-charged bodies apparently repelled. This, however, was found inconvenient for the explanation of many phenomena, and hence they were led to the assumption that the particles of common matter, when the body which they composed was deprived of its ordinary quantity of the electrical fluid, actually repelled each other. Such shifting of ground proves, if it proves anything at all, the defectiveness of the whole theory.

* Franklin speaks of common matter and of electrical matter.

Dr. Franklin himself, in a letter to Mr. Collinson, entitled "Opinions and Conjectures Concerning the Properties and Effects of the Electrical Matter," takes occasion to explain many electrical phenomena by his own hypothesis, but towards the end of the letter he makes this remark: "and every other appearance I have yet seen, in which glass and electricity are concerned, are, I think, explained with equal ease by the same hypothesis. Yet, perhaps, it may not be a true one, and I shall be obliged to him that affords me a better."

One other remark I shall quote from Dr. Franklin's letter, to show that he placed more importance on observing and knowing the phenomena than on formulating hypotheses or theories about the *causa operandi*:

"Nor is it of much importance to us to know the manner in which Nature executes her laws; 'tis enough if we know the laws themselves. 'Tis of real use to know that china left in the air unsupported will fall and break; but *how* it comes to fall and *why* it breaks are matters of speculation. 'Tis a pleasure, indeed, to know them; but we can preserve our china without it."

No one seemed to have attacked Franklin's theory till 1759, when Symmer, on December 20 of that year, read a paper to the Royal Society. In previous papers he gives a minute account of the electric phenomena observed by him in pulling off and putting on white and black silk stockings. The papers are most interesting reading, and shew the careful and observant experimenter in every line. However, it is with his paper on "Two Distinct Powers in Electricity" that I have to deal to-night, and I shall first quote a sentence from his own paper, and then go on to offer a few remarks on his theory.

Symmer says: "My notion is, that the operations of electricity do not depend upon one single positive power, according to the opinion generally received, but upon two distinct, positive and active powers, which by contrasting, and, as it were counteracting each other, produce the various phenomena of electricity; and that when a body is said to be positively electrified, it is not simply that it is possessed of a larger share of electric matter than in a natural state, nor when it is said to be negatively electrified, of a less; but that, in the former case, it is possessed of a larger portion of one of those active powers, and in the latter, of a larger portion of the other; while a body, in its natural state, remains unelectrified, from an equal balance of those two powers within it."

Symmer proceeds to substantiate this statement by reference to a series of experiments carried on by himself singly, and also to some carried on by him in presence of Dr. Franklin. Two of the chief experiments enumerated are the discharge from a Leyden phial, and the appearance of the hole caused by a spark from a machine in a thick piece of paper, or rather in a pile or quire of thin papers pressed close together. The reasoning is well known to you all, as a summary is given in most text-books, but if any of you are curious on the matter or would like to read Symmer's own words, you will find them in a series of papers communicated by him to the Royal Society in the year 1759. The papers are well worth reading. The reasoning is very close, and the experiments are described most minutely. Paper IV. both Parts I. and II. will repay a careful reading. In Part II. he refutes successfully the arguments of Nollett, who seemed to think that electricity was constituted by the simultaneous effluence and affluence of a fluid matter, extremely subtile. This, as Symmer remarks, is only an electrical phenomena, not the principle upon which all electrical appearances depend.

Both the electrical fluids, or, as he prefers to say, the emanations of the two distinct electrical powers, are essentially different from each other. Electrification consists in the accumulation of the one or the other kind of electric fluid. Excitation is caused by the interchange of the electric fluids between the rubbed and rubber. Induction is caused by the separation of the two neutralising fluids of a neutral body, occasioned by the near presence of a body having either fluid in excess. Attraction is a direct consequence of this induction, as the opposite electricity is attracted to the side of the body next the charged body.

About the same time, I believe in the same year—viz., 1759—Æpinus, a celebrated German philosopher, also promulgated a hypothesis of electricity on the same lines as that of Franklin's. He speaks of an electric fluid, and says that it exists in the pores of bodies; that it moves without any obstruction in non-electrics, such as metals, but that it moves with extreme difficulty in electrics, such as glass, &c.; that its particles repel each other with a force decreasing as the distance increases; that there is mutual attraction between its particles and the particles of common matter, also decreasing as the distance increases; that the transference of the fluid from one body to another constitutes electrical phenomena.

Cavendish, twelve years later (1771), read a paper before the Royal Society, in which he advocates a theory somewhat similar. He did not know of the theory of Æpinus when he wrote his paper. Cavendish also speaks of an electric fluid, the particles of which repel each other with a force inversely as some* less power of the distance than the cube, and attract the particles of other matter by the same law. Every body in its natural state is saturated with electricity—that is, it contains such a quantity of electric fluid interspersed among its particles that the attraction of the electric fluid on any given particle of it is equal to the repulsion of the rest of the body on the same particle. A body is overcharged when it contains more than this quantity of the electric fluid; and undercharged when it contains less. Bodies overcharged or undercharged repel each other; an overcharged body and an undercharged body attract one another, &c. Upon this hypothesis Cavendish bases a most learned mathematical investigation, which, though of great value, I beg leave to pass over in this paper.

In another paper of Cavendish's, entitled "Thoughts Concerning Electricity," which Sir W. Snow Harris considers as a revise of his paper to the Royal Society, but which Clerk-Maxwell considers—

* In later papers he states inversely as the square.

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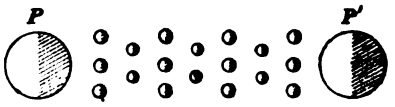
rightly, I think—as an earlier form of the theory which he embodied in that paper, many ingenious speculations are advanced. I shall content myself, and you also, perhaps, by quoting a few sentences only: "Electricity seems to be owing to a certain elastic fluid interspersed between the particles of bodies, and, perhaps, also surrounding the bodies themselves in the form of an atmosphere. The fluid, if it surrounds bodies in the form of an atmosphere, seems to extend only to an imperceptible distance from them; but the attractive and repulsive power of this fluid extends to very considerable distances."

In a foot-note is remarked: "I imagine that the distance to which the electric atmospheres—if there are any—extend must be less than the smallest distance within which two bodies can be made to approach." Again he says: "That the attraction and repulsion of electricity extend to considerable distances is evident, as corks are made to repel by an excited tube held out at a great distance from them. That the electric atmospheres themselves cannot extend to any perceptible distance, I think, appears from hence, that if two electric conductors be placed ever so near together so as not to touch, the electric fluid will not pass rapidly from one to the other except by jumping in the form of sparks, whereas, if their electric atmospheres extended to such a distance as to be mixed with one another it should seem as if the electricity might flow quietly from one to the other, in like manner as it does through the pores of any conducting matter."

The three theories that I have thus briefly referred to were published within 1747 and 1771—twenty-four years. I shall now pass over the next sixty years, years most prolific in electric discoveries, for during these years Galvani, Coulomb, Davy, Laplace, Lavoisier, Volta, Poisson, Oersted, Arago, and Ampère lived, experimented, and published their electric discoveries, discoveries which make their names for ever remembered in connection with this subject. I, in fact, ask you to come down to the year 1831, when Faraday commenced his brilliant series of experimental researches. Faraday, though his researches serve to throw a light on the probable nature and laws of electric action, formulated no distinct hypothesis of what electricity is. He invariably speaks of electric force, and not of electric fluid, as his predecessors did, although I may add that one, at least, of his predecessors, namely, Eales, an Irish gentleman, who wrote on the subject of electricity, speaks of two opposite electrical forces or powers. But as he also speaks of electric fluid, it is difficult to make out whether Eales himself had any distinct idea of what he meant by electric force.

Faraday was, indeed, very careful not to lend his support to any previously promulgated theory. He says: "The effects may depend upon the association of one electric fluid with the particles of matter, as in the theory of Franklin, Epinus, Cavendish, and Mossotti; or they may depend upon the association of two electric fluids, as in the theory of Du-Fay and Poisson; or they may not depend upon anything which can properly be called the electric fluid, but on vibrations or other affections of the matter in which they appear. The theory is unaffected by such differences in the mode of viewing the nature of the forces, and though it professes to perform the important office of stating *how* the powers are arranged (at least in inductive phenomena), it does not, so far as I can yet perceive, supply a single experiment which can be considered as a distinguishing test of the truth of any one of these various views."

The great advance which Faraday made on his predecessors is the way in which he regarded induction. This distinction is very well put by Clerk-Maxwell in his preface to his "Treatise on Electricity and Magnetism": "Faraday, in his mind's eye, saw lines of force traversing all space, where the mathematicians saw centres of force attracting at a distance; Faraday saw a medium, where they saw nothing but distance; Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they had found it in a power of action at a distance impressed on the electric fluids." Thus, according to Faraday's view, induction takes place by the polarisation



of the intermediate particles. Let P be a positively electrified body; then P' is inductively affected through the intervening molecules becoming similarly inductively affected. If the intervening molecules can maintain their state as represented in figure, then we have insulation; if not, we have equalisation between P and P' effected.

Remember, however, that induction does not depend on the existence of such intervening *material* particles—at least, not on the little impenetrable, hard, pieces of matter of the commonly received notion. For, as he remarks in a letter to Richard Taylor, Esq., "A mind just entering on the subject may consider it difficult to think of the powers of matter independent of a separate something to be called the *matter*, but it is certainly far more difficult, and, indeed, impossible, to think of, or imagine the *matter* independent of the powers. Now, the powers we know and recognise in every phenomenon of the creation, the abstract matter in none." Nowadays, it is a question whether the electric forces are transmitted through bodies by strains of their own particles, or by strains of the ether, or partly by the one and partly by the other. A knowledge of this point would enable us to account for the difference between good conductors and bad conductors of electricity.

A *résumé* was also given of the "Modern Views of Electricity," also of, or with special reference to, the articles appearing in *Nature* on the subject, written by Dr. Oliver Lodge.

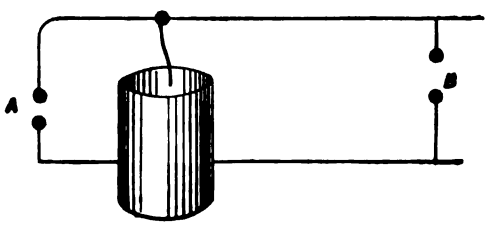
FRANKFORT.—The construction of a central station at Frankfort, for the public lighting of the streets, is put up to tender, by decision of the Municipal Council.

LIGHTNING CONDUCTORS.

JOINT DISCUSSION IN SECTIONS A AND G OF THE BRITISH ASSOCIATION.

(*Continued from page 255.*)

Prof. O. J. Lodge opened his case with the confession that he had had nothing like the experience of Mr. Preece on which to base his remarks. He had not a lightning conductor to his house, nor had they one at University College, Liverpool. He had asked the authorities to put one up, but their reply had been that lightning conductors, at present, seemed to be so expensive that it was cheaper to insure. He rather thought there must be some fallacy in that argument, which ought to be treated in Section F. Manufacturers often went on that principle. It was perfectly true that, if his views were correct, very few buildings could be said to be effectively protected at the present moment; but, on the other hand, if they were true, then lightning conductors would in the future be able to be bought for as many shillings as they then cost pounds. Mr. Preece had poked some fun at mathematicians; but as he (Prof. Lodge) could hardly pretend to be a mathematician, he would not say anything about the matter. At the same time, he was quite willing to argue the point without the help of mathematics; and, as far as self-induction was concerned, he had no objection to call it electro-magnetic inertia, though that term might seem to imply more than they then knew for certain. In using it, they would rather seem to imply a knowledge which they did not then possess. When they did possess it, they would be a great deal nearer to the statement that electricity was a form of matter. He did not think Mr. Preece recognised how near he went, when he spoke of electro-magnetic inertia, to the assertion that electricity is a form of matter. Mr. Preece's argument was that electricity is a form of energy because it can be made to be bought and sold, but they might as well argue that sugar is a form of energy for the same reason. Mr. Preece also argued that electricity is not a form of matter because they could make it do work, but the hydraulic engineer might equally well argue that water is not a form of matter because with water they could do work. He had very carefully read the report of the Lightning Rod Conference to which Mr. Preece drew attention, and in it he had found particulars of many failures of rods. A noteworthy instance often cited was that of a church, he believed in Italy, where rod and steeple was destroyed, the flash being seen by a number of people. In his lectures he had quoted as the best-protected building in the world the Hotel de Ville at Brussels, where M. Melsen's system was adopted, and on which he had spent so much trouble. That building was elaborately protected. It had a number of conductors, bristled with points all over the top—had good earths, and, in fact, was carried out in the most approved style, regardless of expense. But in the month of June last that building was struck and set on fire. The particulars of the occurrence had not been published, though he thought they ought to be, as they would be of great interest. He did not think it could be said that existing conductors never failed. Then Mr. Preece had a hit at him, and he admitted he was at a disadvantage here, when he quoted a sort of Midlothian speech of his (Prof. Lodge's) in which he had made an entirely erroneous statement (that quoted from *Nature*, as to the relative value of iron and copper for conductors). That was a mere parenthesis, hastily thrown in, and must not be adduced as a statement based on mathematical calculation. When the Society of Arts asked him to give a lecture on lighting conductors, he thought to himself, "Yes, I will tell them about self-induction," because he knew that the Lightning Rod Conference had not called attention to that under the name magnetic inertia, or any other. He happened to be writing a paper which appeared, he thought, in *Nature*—he was not sure where the quotation made by Mr. Preece came from—and in that paper, having regard to the magnetic permeability of the two metals, copper and iron, he had stated that in regard to the magnetisability of its substance iron was 90,000 times worse than copper. He meant to say, therefore, that although iron was cheaper, was more difficult to melt, had a higher specific heat, and in a variety of ways was better than copper, yet, in regard to this electro-magnetic inertia, it was enormously worse. Before actually giving the Mann lectures, however, he made a few experiments on this point, and to his surprise he found that, so far from being worse, iron was often rather better; and that even a thin wire of iron carried off the discharge better than a thick wire of copper. This experiment naturally and at once effected his conversion.



The experiment referred to was that of the alternative conductor; it might be of iron or copper, or any other metal, of any thickness they wished to experiment upon. The top part of the arrangement sketched by Mr. Preece was of no particular interest; at least, they need not attend to it now—the bottom part was the thing. The B spark measured the E.M.F., which drove the current through the alternative path. They should adjust the B part until the flash produced there did not know which way to go—whether to go through the wire or through the air. Half the sparks failed when that is attained. With a spark micrometer at B they measured the distance, and thus obtained the E.M.F. which is on the verge of succeeding in

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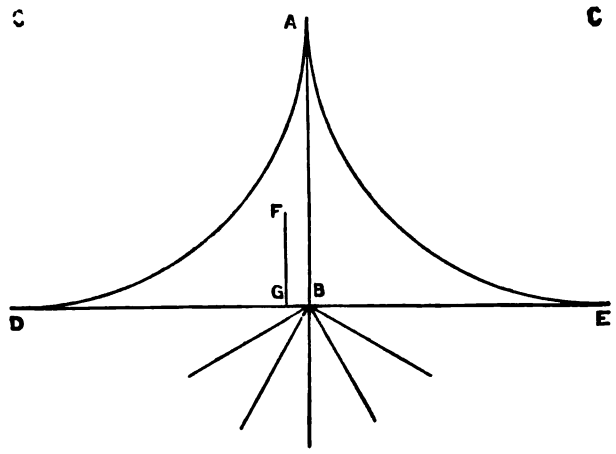
driving the contents of the jar through the wire. He tried first a thick copper wire, and afterwards he tried a thin iron wire of the same length; he found that a greater distance of spark, a greater E.M.F., was needed to drive the contents of the jar through the thick copper wire than through the thin iron wire. Whatever explanation might be given of an experiment of that kind, a direct intimation from heaven could be no clearer. For some reason or other the copper and the iron are at least equally good. He did not press the point that iron is *better* than copper, and he had never stated that copper has more self-induction than iron—that would be a mad thing to say; but it might happen, for some reason or other, that copper obstructed the current more than iron. He preferred, however, to say that the two metals were equal. The Society of Arts did not ask him to bless the Lightning Rod Conference. There were three parties in the little drama alluded to by Mr. Preece. He himself had been likened to Balaam—he supposed the Society of Arts was Balak—but he did not know who was the third party, unless he was the party who spoke against the prophet. Now, Mr. Preece said that the function of a lightning conductor was to prevent a flash from striking it. That was to say, that conductors never ought to be struck, or they failed. But they were struck, because they got melted, and yet he (Mr. Preece) said they never failed. If a conductor could prevent a flash, well and good. But he had shown that there were cases in which a point had no protective action whatever. There were other cases where a point acted to neutralise a flash. A rod had two functions: to act as a preventive when it could, the other to carry off flashes. The energy must be dissipated somehow, they could not hocus pocus it out of existence, and the quicker they tried to carry it down to earth the more surging they got. It might be better to let it go down gradually than as quickly as possible. He wished he had any information concerning the length of flashes, but he had not. It was very important to know the length of a flash. Whether the spark length was proportional to the distance or not, he would remark that the experiments with oscillating currents were carried out with alternating transformers. Concerning the length of flashes, he wished he had first-hand information, but he had none; it was one of those things which meteorologists must determine. It was very important to know the length of the flash. He had seen it stated in books that the flashes were a mile long and perhaps more. Mr. Preece thought they were only 500ft. long; that was a matter of fact which could be investigated, but that was a matter upon which he had no direct first-hand information. As to whether the spark length is proportional to the distance or not, he would say that the experiments with oscillating currents to which Mr. Preece magnanimously called his attention yesterday, were conducted with alternating dynamos between points. Now the area of cloud and the area of earth below it are not points; they are flat surfaces, like the coats of a Leyden jar.

Mr. Preece: They were alternating transformers.

Prof. Lodge replied that they were alternating currents as used in practical commercial work discharging between points. There the law did not seem to hold; but then it ought not to hold, so that would be all right. But between flat surfaces it ought, and the spark length ought to vary with the difference of potential between the two flat surfaces. At the same time, if there were points on the earth's surface which were big enough, and if these points determined the flash, then the law of proportionality would not hold. However, the laws concerning discharge in dielectrics were well known, and were scarcely matters for argument. The circumstances of an oscillating current did not apply as regards the length of the spark, because until the discharge occurred there was no oscillation; it was a mere static charge. The earth and the cloud above it are exactly like the coats of a Leyden jar, which are preparing to spark into one another, and which do spark into one another when the difference of potential rises to a certain maximum, and the air between is broken down. He had seen flashes which certainly appeared to last several seconds; he thought these were a series of multiple flashes. But whether they lasted long or not, there was no necessary argument that they were not oscillatory. The fact that they deflected the compass needle did not prove anything about it, because a ballistic galvanometer was deflected by a momentary kick. But there was a difficulty, and that was to be found in the magnetising power of the flash, and that was Mr. Preece's strongest point. An oscillatory current ought not to produce magnetising effects. Such a current was used by Prof. Ewing to demagnetise steel, not to magnetise it. It would be of the nature of a gradually decaying vibration. The same difficulty, however, would be felt with a Leyden jar, the current from which was oscillatory, and yet it magnetised steel needles. He did not fully understand this, and hoped Lord Rayleigh would say something about it. (Prof. Lodge then explained his idea of oscillating currents by the analogue of a pendulum—a straight stick held between finger and thumb, oscillating in water or treacle. In the former case the oscillations would go on longer than in the latter, but would die out quicker, because of the lesser viscosity of the former fluid. The surfaces also would be disturbed in the shape of waves, which would render the analogy complete.) What the energy of a flash was he did not know, but it would be very important to determine it. Whether a flash was likely to be oscillatory or not, depended on the resistance compared with the capacity and inertia of the discharge. The smaller the capacity, and the greater the electro-magnetic inertia, the more likely to be oscillatory. The quantity of electricity in a thunder-cloud was small, but its potential was enormous. With regard to the area of protection theory, Mr. Preece said if a conductor did not protect an area, what was the good of it? but that was no argument that it did protect an area. Mr. Preece's area was so small that they might give it him without much argument. (Prof. Lodge then showed by a diagram what was the protected area according to Mr. Preece. Here, D E is the base line and A the height of conductor, the protected area being the area within the arc of circle described from centre C, the earth and the rod. Why did he object to such a bit of protection? But even this area was not perfectly protected, for there might be a side flash to any conductor, as F, G. If a man held a lightning conductor when the flash passed down it he would most likely be killed, and if it passed through gunpowder—well, he did not know about gunpowder, because gunpowder got blown about. It did not matter about the earth: let the intended conductor have a good earth and this supplementary one a bad earth, still the same effect will occur; a spark is likely to occur if the



distance be not too great. He said that is so because he had made experiments in the laboratory after this fashion, amongst others. He took a rod which might be of copper as thick as they pleased, he put it in circuit with a Leyden jar, sending the discharge through the rod—this was a solid rod of copper. Take a Wollaston platinum wire, or any other wire, as fine as possible so as to make the contrast greater, and arrange it to make a kind of tapping circuit; arrange so that the bottom end shall be in contact with the rod, and the top end an eighth or a sixteenth of an inch away. There they had a splendid conductor, better than any lightning conductor ever was. They would have no trouble about earth, as they had a little tapping circuit close to it—the Wollaston wire, which they could hardly see. It seemed absurd for any portion of the discharge to leave this inch-thick conductor to jump across a sixteenth of an inch of air space, and to make for the little thread of wire. Nevertheless a portion of it does, and from every spark that goes through the conductor a side branch goes to that little wire. He did not know that he had taken all the points mentioned by Mr. Preece, but he had dealt with enough for the patience of his hearers. There was one point where Mr. Preece might have attacked him, and that was, What were the conditions of lighting? He had assumed that a flash behaved as did a spark in a laboratory. But the condition which obtained for thunder-clouds were not obtained in the laboratory, and if they wanted to get an answer to the question they must observe lightning. Mr. Abercromby had a photograph there in which the flash was seen to be breaking the air down in all directions at once. It is most extraordinary the way in which there seems to be a sort of *rot* set up in the air, so that when one flash begins the whole region smashes up in all directions. There was another recently discovered point which could only now be just called attention to—namely, the effect of the light of one spark in assisting others to form. A spark of an induction coil here will be able to start the spark of another induction coil up in the gallery merely by its light; if it is closer it will do it better, but it will do it at very considerable distances. When they considered the very bright light of a lightning flash, this effect must have very important consequences. There was no doubt that once a flash occurred the light of it must make all conductors in the neighbourhood—all the air in the neighbourhood—very easily able to break down, and so may give rise to a multiplicity of flashes from all the neighbouring points. That was why he said the idea of areas of protection was misleading. If one flash caused a lot of others, you had better not have the one if you can help it. Therefore, he said, do not run up great long rods to precipitate flashes near powder magazines, or anywhere where it is dangerous, but try to avoid them if possible. If there must be one, they must be very careful indeed to have all the other conductors arranged so that the sparks along them do not matter, because if one flash occurred they were likely to get others. Mr. Glazebrook had just asked him to describe the effect of light in producing a spark. There was no difficulty in it; they merely wanted two induction coils. Take a common induction coil and separate its terminals until they just cannot spark into one another; let the coil be working, but let the sparks just fail to pass. Light a bit of magnesium wire and they would instantly begin to go; take the magnesium wire away and they will stop. Instead of magnesium wire have another coil or a Holtz machine, or anything else, to make the light. Let one be just on the verge of sparking, and let another instrument in another part of the room begin sparking: if the light of that spark can fall upon the space between the terminals of the first, especially upon the cathode of this space, these sparks will begin to pass too. The light of a spark, or ultra violet light in general, seems to make air conduct; a more accurate statement would be that it seems to diminish the transition resistance between the metal and the air, especially upon the surface of the cathode.

The **Hon. Ralph Abercromby** said he wished to contribute to the discussion some facts bearing on the subject that had been discovered by means of about ninety photographs of lightning flashes collected by a committee of the Royal Meteorological Society, to which he acted as secretary, and a few of the more remarkable of which he brought for inspection. In doing so he proposed to confine himself entirely to such facts as related to the discussion. The first point was, "Is there any evidence in a photograph as to the passage of successive flashes along the same path?" He thought the answer was that there

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was no certain evidence. Sometimes there was an undoubted tendency of flashes to follow nearly the same path, though at other times the lightning flew irregularly all over the field of view. In some pictures the streaks of light were exactly parallel, but this effect was almost certainly due to duplication by optical defects. (2) An inveterate tendency of flashes to ramify, or to send offshoots from the main branch, was one of the commonest features revealed by photography. Numberless eccentricities of lightning were reported when buildings were struck; but nothing could be more irregular than the course of some of the flashes exhibited. The same tendency to fly off was found in the discharge of powerful electrical machines. He thought some of this irregularity might be due to electric discharge through rain, and that it would be worth while to note, when damage was recorded, whether it was raining or not. (3) The flash was not always so instantaneous as was sometimes supposed. Flashes sometimes meandered in such a manner that it was impossible to suppose the discharge zigzaged and turned in loops except in a very approciable length of time. There was nothing out of the way in such a conception, for besides practically instantaneous flashes, there was the well-known globular discharge which moved no quicker than a cricket ball, and it was inconceivable that there were not intermediate rates of discharge. It was well known that the photographs of many lightning flashes exhibited a ribboned structure, and it had been suggested that that appearance might be due to shaking of the camera, and evidence thereby obtained of a not very rapid discharge. Some of the pictures exhibited proved, however, that ribbon structure was not due to shaking. He would not venture to say anything about the practical application of these facts, but believed that Dr. O. Lodge had materially contributed to the protection of buildings by calling attention to the defects of the systems at present in vogue. It might, perhaps, interest the meeting to know that the scheme for the systematic observation of British thunderstorms sketched before the association at Manchester was now working. The large amount of material which had already been collected had not yet been discussed, but he hoped to discover, among other things, whether, as in Norway, certain classes of thunderstorms were much more destructive to buildings than others. He thought 500ft. for the height of a thunder-cloud, as mentioned by Mr. Preece, exceptionally low; but many were not more than 1,000ft. or 1,500ft. high, and by far the greatest proportion of lightning discharges took place at an altitude under 10,000ft.

(To be continued.)

MEASUREMENT OF ELECTRO-MAGNETIC WAVE LENGTH.*

BY PROF. OLIVER J. LODGE, F.R.S.

When returning thanks for the reception of his address yesterday morning, our President thought fit to disclaim too much share in the suggestion of an oscillatory Leyden jar circuit as a practicable source of radiation of moderate wave length. But such a disclaimer he must not be allowed to make. He mentioned as coming before himself the names of Feddersen and other German experimenters on these alternations. But to them belongs not this credit, but another. What they accomplished was the experimental verification of the existence and the counting of the frequency of these already predicted oscillations. Prior credit must therefore be put further back. As is very well known, Helmholtz in 1847 suggested that a Leyden jar discharge must be oscillatory in a circuit of small dissipation, and Sir William Thomson in 1858 calculated out the whole details of the process and gave its equation; an equation which, though we now write it down glibly enough, was at that date unintelligible and difficult of comprehension to all but a very few—perhaps to all without exception—not the mere equation, of course, but the co-efficient A which it contained, the electro-dynamic capacity of the discharger, or, as we now call it, the self-induction or inductance of the circuit. Every important detail of this prediction has now been verified by the labours of the German experimenters, Feddersen, Schiller, and others. But any idea that radiation was propagated through the ether by such oscillations I am sure had never occurred to them. I remember the history of the thing pretty well, because I had been thinking much myself on the direction of how directly to manufacture light—*i.e.*, how to construct an electrical oscillator of a given and sufficient frequency. In fact, a year or so before the Southport meeting I suggested to this section a plan whereby I fancied it might be done. That particular plan I saw soon afterwards to be incapable of working, and the suggestion has therefore no merit. But it made me able to clearly appreciate the suggestion, or rather the certainty which was expressed by Prof. Fitzgerald at Southport, that the oscillations in a discharging Leyden jar circuit were just the things that would be practicable, and which would generate light of some measurable, though no doubt still considerable, wave length.

More recently Lord Rayleigh showed at a Friday evening discourse in the Royal Institution some remarkably beautiful interference experiments in sound, whereby inaudible sound waves could be detected, measured, converged, and, in fact, treated in just the same manner as one is accustomed to treat light waves.

Putting the two things together, I was hopeful of being able to attack the problem experimentally and to prove the existence of radiation with measurable wave lengths from a Leyden jar circuit, by interference experiments conducted after the model of Lord Rayleigh's. Meanwhile I happened to be experimenting on lightning conductors, and somewhat to my surprise, as an outcome from those experiments, I hit on an arrangement which, without any thought or scheming at all, gave me evidence of the very waves I had been thinking so much about, and enabled me to measure their lengths, though not in a previously planned-out way. I described these experiments quite hastily and briefly, in the midst of other matter, in a lecture to the Society of Arts last March on lightning conductors, as the experiment of the recoil kick.

I continued the experiments after the lecture and proved the existence of ether waves of various lengths—the shortest wave that I obtained distinct evidence of being three yards. I intended to describe those experiments at this meeting with a reference to the Southport suggestion of Prof. Fitzgerald's, quite unknowing at the time that we should have the pleasure of seeing him in the chair. However, when going away from Liverpool on a holiday I read in the train the July number of Wiedemann's *Annalen*, and there found that Dr. Hertz had obtained much better and more striking evidence of these electro-magnetic waves, and had measured their length by an interference experiment exactly like one of those used by Lord Rayleigh for sound.

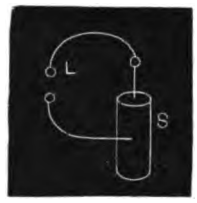

FIG. 1.

I hasten to acknowledge the superiority of Hertz's method of demonstration to my own; and so far as evidence of the waves is concerned, a description of my experiments is now superfluous. Nevertheless, the mode of propagation of the pulses and their mode of reflection is different in my experiments from what they are in those of Hertz, and although mine is not so good a method, yet it may have some interest as confirming the view taught us by Poynting and others concerning the mode of propagation of energy through the ether, and the theory of Kirchoff and Heaviside concerning the rate of transmission of signals by a telegraph wire.

The theory of the experiment is given in my paper in the August number of the *Philosophical Magazine*.

The velocity of a pulse along a wire is $\frac{1}{\sqrt{l_1 s_1}}$, where

$$l_1 = 4\mu \log \frac{b}{a} + \frac{r_1}{\mu}$$

and where $r_1 = \sqrt{\frac{1}{2} p \mu_0 R_1}$ $\quad s_1 = \frac{K}{4 \log \frac{a}{b}}$

So velocity of pulse along a wire $= \frac{1}{\sqrt{\mu K}}$ the same as in free space.

Now take an oscillatory Leyden jar circuit and apply Thomson's theory to it.

$$p = \frac{1}{\sqrt{L S}}$$

Now if this circuit emits waves of velocity, V, their length in free space is

$$\lambda = \frac{2\pi V}{p} = 2\pi \sqrt{\frac{L}{\mu} \frac{S}{K}}$$

Along two parallel wires they go at the same pace, and therefore have the same length. Hence combine the two things. And we have waves of known length propagated along the wires.

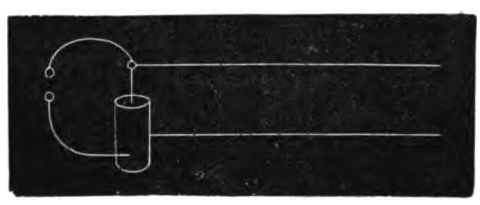

FIG. 2.

Now take the wires of finite length. At the free ends we shall have reflexions, a sort of recoil or kick, evidenced by a brush discharge or spitting off from the ends of the wire, and in the dark the far ends of the wires glow. Supply these with knobs, and we get surprisingly long sparks.*

FIG. 3.

When may we expect to get the longest sparks? When the periods of oscillation of the circuit and of the appendages to it are the same.

* Paper read at the British Association at Bath.

* For instance, A = 4·4; B = 15. (Fig. 3.)

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This will be when the length of each wire is half a wave length, or some multiple of half a wave length. The two will then vibrate together like a resonant column.

My experiment consisted, then, in so varying the current or the resonant wire that the recoil kick is a maximum.

The results of varying L are shown by some such curves as this, where horizontal distance represents distance of A knots from jars, and where vertical ordinates represent length of B spark :

FIG. 4.

and are such as entirely to confirm the theory so far as the accuracy of the experiments go.

It is much easier to get good measurements with fairly big condensers, and therefore long waves, else the energy is not sufficient to give very marked results. With very long wires arranged out of doors on a dark night I hope to get evidence of modes by the periodic glow.

The experiments with shorter waves were made with an adjustable tube condenser, various lengths of which could be used, and on the shortest waves, with a mere coated disc condenser the size of a penny.

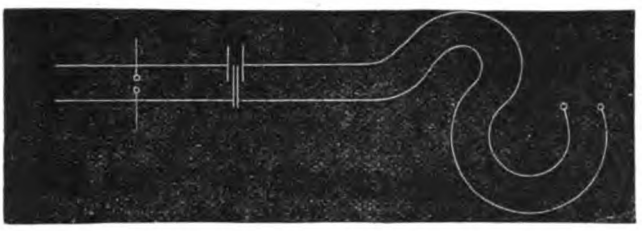

FIG. 5.

To get frequencies of the rapidity of visible light the linear dimensions of the circuit must be something comparable to 10^{-6}, and so electric oscillations in atoms will give rise to ultra-violet rays.

[ABSTRACT.]

The author has been endeavouring to manufacture light by direct electric action without the intervention of heat, utilising for the purpose Maxwell's theory that light is really an electric disturbance or vibration. The means adopted is the oscillatory discharge of a Leyden jar whose rate of vibration has been made as high as 1,000 million complete vibrations per second. The waves so obtained are about three yards long, and are essentially light in every particular except that they are unable to affect the retina. To do this they must be shortened to the hundred-thousandth of an inch. All that has yet been accomplished, therefore, is the artificial production of direct electrical radiation, differing in no respect from the waves of light except in the one matter of length. The electrical waves travel through space with the same speed as light, and are refracted and absorbed by material substances according to the same laws. It only wants to be able to generate waves of any desired length in order to entirely revolutionise our present best systems of obtaining artificial light by help of steam-engines and dynamos, which is a most wasteful and empirical process.

THE ELECTRICAL TRANSMISSION OF POWER.*

BY PROF. AYRTON, F.R.S.

(Concluded from page 233.)

In this experiment there is, as a matter of fact, still more transformation than that I have yet mentioned, because whereas in actual practice the alternate current dynamo, as well as the small dynamo used to produce the current for magnetising the electro-magnets in the alternate current dynamo, would be worked by a steam, gas, or water-engine. I am now working them both by electromotors, since a steam-engine or a water-wheel would be an unsuitable occupant of the drill hall. Practically, then, a steam-engine on the land belonging to the Midland Railway Company on the other side of the Lower Bristol-road is driving a Thomson-Houston dynamo. This is sending a small current working these high voltage constant current Immisch motors. The motors being geared with low voltage dynamos the potential difference is transformed down, the first alternate current transformer transforms it again, and the second alternate current transformer transforms it down again, so that there are, in fact, three transformations taking place in this experiment on the platform before you. A vast district in London, extending from Regent's Park on the north to the Thames on the south, from the Law Courts on the east to Hyde Park on the west, has over 20,000 incandescent lamps scattered over it, all worked from the Grosvenor Gallery in Bond-street by means of alternate current transformers, which convert the 2,000 volts maintained between the street mains into 100 volts in the houses, and the London Electric Supply Company have arranged for a vast extension of this system to be worked from Deptford.

In America alternate current transformers are, due to the remarkable enterprise of Mr. Westinghouse, used to light 120,000 incandescent lamps in 68 towns. In fact, the electric lighting of a whole town from a central station begins to excite less astonishment than the electric lighting of a single house did ten years ago.

The efficiency of a well-made alternate current transformer is very high, being no less than 96·2 per cent. when the transformer is doing is full work, and 89·5 per cent. when it is doing one quarter of its full work, according to the experiments made by our students. It certainly does seem most remarkable, and it reflects the highest praise on the constructors of electrical machinery that motor power can be converted into electrical power, electrical power at low pressure into electrical power at high pressure, or electrical power at high pressure into electrical power at low pressure, or, lastly, electrical power into motor power, in each case with an efficiency of 94 per cent.

As a further illustration of the commercial importance of this electric transformation, I will show you some experiments on electric welding—one of the latest developments in electrical engineering. To weld a bar of iron one square inch in section requires a gigantic current of some 13,000 amperes. To convey this current even a few yards would be attended with a great waste of power. Consequently, while an enormous current is passed through the iron to be welded, only a comparatively small current is transmitted along the circuit from the dynamo to the welding apparatus. Mr. Fish, the representative of Prof. Elihu Thomson, of America, to whom this apparatus is due, will be so kind as to first show us the welding together of two bars of square tool steel, the edge of each bar being $\frac{1}{2}$in.; and the operation is, as you see, entirely completed in some 15 seconds. For this experiment, an alternate current of 20 amperes will be produced by the dynamo at the other side of the Lower Bristol-road, and this current will be converted by the transformer on the flat form into one of 9,000 amperes large enough for 12,000 of those incandescent lamps if these were placed in parallel and the current divided among them. He will next try welding some thicker bars, and lastly, he proposes welding together two pieces of aluminium, which it is extremely difficult, if not impossible, to weld in any other way. The bars, as you see, are in each case pressed together end on, and in consequence of the electric resistance of the very small gap between the bars being much higher than that of the bars themselves, the current makes the ends of the bars plastic long before it even warms the whole bar, so that I can, as you see, take hold of the iron or steel two or three inches away from the weld without its feeling hot. The temperature of the weld can be adjusted with the most perfect nicety so as not to burn the steel. The ends of the bars to be joined are softened to the centre, consequently a very good weld indeed can be made electrically by simple end pressure.

We have to thank Mr. Fish not only for showing us the welding, but also for the very valuable assistance he has given us in supplying the electric power for the experiments on transformers and for the electric lighting for the outside of the Drill Hall. That "go-ahead," which is so characteristic a feature of his countrymen, has been ever present in my mind while we have been working together during the last few days.

To Mr. Snell, the representative of Mr. Immisch, we must also give our best thanks for so generously devoting some days of hard work to the arrangement of his high voltage constant current motors, used in driving the alternate current machine, and the small dynamo employed to magnetise the magnets of the former.

This ingenious Telpher model, to which I shall refer later on, is Mr. Bourne's handiwork, and considering that it has been taken to pieces and hastily erected again, it is most creditable to him that it automatically blocks as well as it does.

For the arrangement of the smaller illustrations, and the careful execution of several of the diagrams, I have to thank Mr. Raine.

Did time allow, I should like to describe to you to what perfection the system of economical distribution with accumulators, originally proposed by Sir William Thomson, in 1881, and shown in its very simplest form in the wall diagram, has been brought by Mr. King, the engineer to the Electrical Power Storage Company; how the cells, when they are fully charged, are automatically disconnected from the charging circuit, and electrically connected with the discharging circuit; how the electric pressure on the discharging, or house-mains, is automatically kept constant, so that the brightness of the lamps is unaffected by the number turned on; and how cells that are too energetic have their ardour automatically

* Lecture delivered at the Drill Hall, Bath, on Friday, September 7th, 1888.

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handicapped, and not allowed to give more current than is being supplied by the less active ones.

During the last few months fierce has been the battle raging among the electricians, the war-cry being "alternate current transformers versus accumulators"; while the lookers-on—with that better view of the contest that they are proverbially said to possess—have decided that the battle is a drawn one. Neither system is the better under all circumstances; if the district to be lighted be a very scattered one, use alternate current transformers by all means, but if the houses to be lighted are clustered together at a distance from the supply of power, then the storing property possessed by accumulators, which enables the supply of electric power to far exceed the capacity of the dynamos and engines in the busiest part of the twenty-four hours, will win the battle for accumulators. Any direct current system of distribution, such as is furnished by accumulators, has also the very great advantage that it lends itself to the use of the very efficient electro-motors which I have been using this evening. Alternate current motors do exist, but they are still in the experimental stage, and are not yet articles of commerce.

Secondary batteries have caused much heart-burning for their uses from the apparent fickleness of their complex chemical action, yet but imperfectly understood. But we have at length been taught what is good and what is bad treatment for them, and after years of brave persevering application on the part of the Electric Power Storage Company, that forlorn hope, the secondary battery, has become one of the most useful tools of the electrical engineers, and secondary cells, some of which, thanks to the kindness of that company, I am using here to-night to supply power for lamps and motors, may now be trusted to have a vigorous long life. That company, I learn, undertake henceforth to keep their cells in order, when used for central station work, for 12½ per cent. per annum, and I understand that they have such confidence in them that they anticipate making no little money by incurring this insurance office responsibility. It is not, then, surprising that the Chelsea Supply Company have decided to use secondary batteries on a large scale for the economical distribution of light and power in their district.

Oliver Goldsmith said more than a hundred years ago in his life of Richard Nash, Esq., "People of fashion at Bath, when so disposed, attend lectures on the arts and sciences, which are frequently taught in a pretty superficial manner so as not to tease the understanding, while they afford the imagination some amusement." I want not to be superficial, yet I must not tease your understanding, and so we will not lose ourselves in technical details. If, however, my remarks have led you to appreciate the vast economical importance of using very large electric pressures, and to grasp that by substituting 2,000 volts for 50 volts when transmitting a certain amount of electric power the current can be reduced to the one-fortieth part, and the waste of power when transmitted along a given length of a given wire to the one-fortieth of the one-fortieth—that is, to the 1-1,600th part—your imagination will have been kindled as well as amused.

With a loss on the road of only 11 per cent. M. Deprez has, by using 6,000 volts, transmitted 52 h.p. over a distance of about 37 miles through a copper wire only one-fifth of an inch in diameter. A piece of the actual conductor he employed I hold in my hand; the copper wire is coated with an insulated material, and then with a leaden tubing, so that the outside may be touched with perfect impunity in spite of the high potential difference employed. M. Deprez's dynamo and motor were not nearly as efficient as he could make them now, so that his terminal losses were unnecessarily great, and the efficiency of the whole arrangement, wonderful as it was, not so startling as it would otherwise have been. I have told you that the loss in dynamo and motor has actually been reduced to only 12½ per cent., so that if a dynamo and motor of this efficiency had been used by M. Deprez, the total loss in the whole transmission over thirty-seven miles would have been under 25 per cent. Indeed, by using only 1,250 volts, Mr. Brown has succeeded in transmitting 50 h.p. supplied by falling water at Kriegstetten to Solothun in Switzerland, five miles away, with an entire loss in the dynamo, motor, and the five miles of going and returning wire of only 25 per cent., so that three-fourths of the total power supplied by the water at Kriegstetten was actually delivered to machinery at Solothun five miles away.

In less than twenty years, then, from Gramme's practical realisation of Pacinotti's invention, we have power transmitted over considerable distances by electricity with only a total loss of 25 per cent., whereas the combined loss in an air pump and air motor, or in a water pump and water motor, is 40 per cent., irrespective of the additional loss by friction or leakage that occurs *en route*. We cannot help feeling that we are rapidly arriving at a new era, and that it will not merely be for the inauguration of the quick transmission of our bodies by steam, or the quick transmission of our thought by telegraph, but for the economical transmission of power by electricity that the Victorian age will be remembered.

I showed you a little while ago an electric fire. Was that a mere toy, or had it any commercial importance? To burn coal, to work dynamos, and to use the electric current to light your houses and your streets is clean and commercial, to use the current to warm your rooms, clean, but wasteful, on account of the inefficiency of the steam-engine. But when the dynamos are turned by water power which would otherwise be wasted, the electric current may be economically used, not merely to give light, but also to give heat. And when the electric transmission of power becomes still more perfect than at present, even to burn coal at the pit's mouth where it is worth a shilling a ton may, in spite of the inefficiency of the steam-engine being only one-tenth, be the most economical way of warming distant towns where coal would cost 20s. a ton. Think what that would mean—no smoke, no dust—a reform effected commercially which the laws of the land on smoke prevention are powerless to bring about, a reform effected without the intervention of the State, and therefore dear to the hearts of Englishmen.

I am aware that this idea of burning coal at the pit's mouth and electrically transmitting its power has quite recently been stated to be commercially impracticable. But is that quite certain? for in 1878 it was stated that, although telephones might do well for America, they certainly would never be introduced into Great Britain, as we had plenty of boys who were willing to act as messengers for a few shillings a week. The phonograph was also declared to be worked by a ventriloquist, and electric lighting on a large scale was proved to be too expensive a luxury to be ever carried out.

To-day the electric current is used for countless purposes. Not only is it used to weld, but by putting the electric arc inside a closed crucible, smelting can be effected with a rapidity and ease quite unobtainable with the ordinary method of putting the fire outside the crucible. If one had pointed out a few years ago that it was as depressing scientifically to put a fire outside a crucible when you wanted to warm the inside, as Joey Ladle, the cellarman, found it depressing mentally, "to take in the wine through the pores of the skin, instead of by the convivial channel of the throttle," who would have believed that in 1888 a 500 h.p. dynamo would be actually employed to produce an electric arc inside a closed crucible in the manufacture of aluminium-bronze? Putting a conservative drag on the wheels is a very good precaution to take when going down hill, but it is out of place in the up-hill work of progress.

But of all the many commercial uses to which the electric current may be put probably, after the electric light, electric traction has most public interest. The English are a commercial people, but they are also a humane people, and when, as in this case, their pockets and their feelings are alike touched, surely they will be radicals in welcoming electric traction whatever may be their political sentiments on other burning topics of the day. It is not a nice thing to feel that you are helping to reduce the life of a pair of poor tramway horses to three or four years; it would be a very nice thing to be carried in a tramcar for even a less fare than at present. Now, while it costs 6d. or 7d. to run a car one mile with horses, it only costs 3d. or 4d. to propel it electrically. Indeed, from the very minute details that have recently been published of the four months' expenses of electrically propelling thirty cars at seven and a half miles an hour along twelve miles of tramway line in Richmond, Virginia, it would appear that the total cost, inclusive of coal, oil, water, engineers, firemen, electricians, mechanicians, dynamo and motor repairers, inspectors, linemen, cleaners, lighting, depreciation on engine, boiler, cars, dynamos and line work, has been 1¼d. per car-mile. That is small enough, at any rate; let us hope that it is true. This tramway is, no doubt, particularly favourable for propelling cars on the *parallel* system—that is, the system in which the current produced by the dynamo is the sum of the currents going through all the motors on the cars—without a great waste of power being produced by a very large current having to be sent a very long distance, because the tramway track is very curved, and the dynamo is placed at the centre of the curve, with feeding wires to convey the current from the dynamo to all parts of the track. But even in the case of a straight tramway line, with a dynamo only at one end, it is quite possible to obtain the same high economy in working by employing a large potential difference, and by sending a small current through all the trains in *series* instead of running the trains in *parallel*, as is done on the Portrush, Blackpool, Brighton, and Bessbrook tramways.

This *series* system of propelling electric trains was, oddly enough, entirely ignored in all the discussions that have taken place this year at the Institution of Civil Engineers, and at the Institution of Mechanical Engineers regarding the relative cost of working tramways by horses, by a moving rope and by electricity, and yet this series system is actually at work in America, as you will see from an instantaneous photograph, which I will now project on the screen, of a series electric tramway in Denver, Colorado, and a series electric tramway twelve miles long, on which forty cars are to be run, is in course of construction in Columbus, Ohio. The first track on which electric trams were run in *series* was the experimental "*telpher line*" erected in Glynde in 1883 under the superintendence of the late Prof. Fleeming Jenkin, Prof. Perry, and myself for the automatic electric

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transport of goods. A photograph of this actual line is now projected on the screen. The large wall diagram shows symbolically, in the crudest form, our plan of series working. The current follows a zig-zag path through the contact pieces, and when a train enters any section the contact piece is automatically removed, and the current now passes through the motor on that train instead of through the contact piece. The Series Electrical Traction Syndicate are now developing our idea in England, but it has received its greater development in the States, where the Americans are employing it instead of spending time proving, *a priori*, that the automatic contact arrangements could never work. Mental inertia, like mechanical inertia, may be defined in two distinct ways; inertia is the resistance to motion—that is the English definition—but inertia is also the resistance to stoppage; that is the American definition.

In addition to the small waste of power, and consequent diminished cost of constructing the conductors that lead the current into and out of the passing trains, the series system has another very marked advantage. Some years ago we pointed out that when an electric train was running down hill, or when it was desired to stop the train, there was no necessity to apply a brake and waste the energy of the moving train in friction, because the electric motor could, by turning a handle, be converted into a dynamo, and the train could be slowed or stopped by its energy being given up to all the other trains running on the same railway, so that the trains going down hill helped the trains going up hill, the stopping trains helped the stopping trains. At that time we suggested detailing methods for carrying out this economical mutual aid arrangement, whether the trains were running on the parallel or on the series system. But there is this difference—that whereas on the parallel system it is only when a train is running fairly fast that it can help other trains, the series system has the advantage that, when a motor is temporarily converted into a dynamo by the reversal of the connections of its stationary magnet, the slowing train can help all the other trains, even to the very last rotation of its wheels. Brakes that save the power, instead of wasting it, are of purely English extraction; but their conception has recently come across the Atlantic with such a strong Yankee accent, that it might pass for having been born and bred in the States.

Economy is one feature that gives electric traction the right to claim your attention. Safety is another. This model telpher line *worked on "the post head contact"* system is so arranged that no two trains ever run into one another, for, in addition to each of the three trains being provided with an automatic governor which cuts off electric power from a train when that train is going too fast, the line is divided into five sections connected together electrically in such a way that as long as a train is on any section, A, no power is provided to the section, B, behind, so that if a train comes into section B it cannot move on as long as the train in front is on section A (three trains shown running on a model telpher line with four automatic locks). Whenever a train—it may be even a runaway electric locomotive—enters a blocked section it finds all motive power withdrawn from it quite independently of the action of signalmen, guard, or engine-driver, even if either of the latter two men accompanied the train, which they do not in the case of telpherage. No fog, nor colour-blindness, nor difference of codes of signals on different lines, nor mistakes arising from the exhausted nervous condition of overworked signalmen can with our system produce a collision. Human fallibility in fact is eliminated. While the ordinary system of blocking means merely given an order to stop, and whether this is understood or intelligently carried out is only settled by the happening or non-happening of a subsequent collision, our automatic block acts as if the steam were automatically cut off—nay, it does more than this, it acts as if the fires were put out in an ordinary locomotive, and all the coal taken away, since it is quite out of the power of the engine-driver to restart the electric train until the one in front is at a safe distance ahead.

THE LEGAL POSITION OF CORPORATIONS WITH REGARD TO ELECTRIC LIGHT.

As the question of the legal position of any corporation with regard to the facilities at present in force for the introduction of electric light into provincial towns is one which will continue to arise before municipal authorities, the report to the Electric Lighting Committee, drawn up by Mr. E. T. Brydges, town clerk of Cheltenham, according to their request, to ascertain the legal position in the matter of electric lighting, will probably prove useful also in other cases.

The following is the text of his report:

By section 161 of the Public Health Act any urban sanitary authority may contract with any person for the supply of gas, *or other means of lighting the streets*, markets, and public buildings in their district, and may provide such lamps, lamp-posts, and other *materials and apparatus* as they may think necessary for lighting the same.

Section 55 also of the Cheltenham Improvement Act empowers the corporation to affix and set up lamp-posts and lamp-irons against or upon the palisades of houses, or against walls, as well as in or upon the streets, and to cause the lamps to be lighted with gas, oil, *or otherwise*.

Under these provisions I think the corporation may, without further powers, contract with any person or company for lighting the streets by electricity even if they cannot themselves erect and maintain the necessary works, but inasmuch as, if the corporation erected their own works they would naturally seek to supply private consumers, it would be necessary to obtain powers to do so either under the Electric Lighting Acts or a special Act.

The Electric Lighting Acts of 1882 and 1888 empower local authorities, companies, or individuals, all comprised in the term "the undertakers," on obtaining a license, order, or special Act for that purpose, to supply electricity for *public purposes*, which are the lighting of any street, place of worship, public building, or theatre, and for *private purposes*, which are any purposes to which electricity is applicable except the transmission of a telegram. It is unnecessary to refer more particularly to the mode of obtaining powers by a special Act, except to say that no such Act would probably be granted that did not incorporate, or that materially departed from, the provisions of these Acts, or that contained provisions that would not be inserted in a provisional order. There appears to be no very great difference between a license and a provisional order except in point of limit of time; time of application; and consent to, and right of purchase of, the undertaking by local authorities, as hereinafter referred to.

A license cannot be granted to a company or person without the consent of the local authority, which consent may be given on such conditions as, subject to the approval of the Board of Trade, the local authority may prescribe. It cannot be granted for a longer period than seven years, but with such consent as aforesaid is subject to renewal from time to time.

Notice of application for a license is to be given by public advertisement, and no license is to be granted until the expiration of three months from the first publication of such notice, and if made by a local authority must be made in pursuance of a resolution passed at a special meeting of the authority to be held after one month's previous notice of such meeting.

Provisional orders may be made by the Board of Trade with the consent of the local authority, unless the Board are of opinion that having regard to all the circumstances of the case such consent ought to be dispensed with, and for such period whether limited or unlimited as the Board of Trade may think proper, but in all other respects subject to the like provisions as those with respect to licenses.

When the undertakers are not the local authority, notice of intention to apply for the order must be given by them to the local authority on or before the 1st July in any year.

The undertakers are to be subject to such regulations and conditions as may be inserted in any license, order, or Act with respect to the following matters:

(*a*) The limits within which and the conditions under which a supply of electricity is to be compulsory or permissive.
(*b*) The securing a regular and efficient supply of electricity.
(*c*) The securing the safety of the public from personal injury or from fire or otherwise.
(*d*) The limitation of the prices to be charged in respect of the supply of electricity.
(*e*) The authorising, inspection, and inquiry from time to time by the Board of Trade and the local authority.
(*f*) The enforcement of the due performance of the duties of the undertakers in relation to the supply of electricity by the imposition of penalties or otherwise, and the revocation of the license, order, or special Act, where the undertakers have, in the opinion of the Board of Trade, practically failed to carry the powers granted to them into effect within a reasonable time, or discontinued the exercise of such powers, and
(*g*) Generally with regard to any other matters in connection with the undertakings.

The Board of Trade are empowered to make regulations for securing the safety of the public from personal injury by fire or otherwise, and to amend or repeal any regulations contained in any license, order, or Act.

Local authorities are empowered to make bye-laws for securing the safety of the public.

Expenses incurred by a local authority may be defrayed out of the local rate, and they may borrow money in manner prescribed by the Public Health Act and the Local Loans Act—that is to say, with the consent of the Local Government Board, and for such term not exceeding 60 years, as that board shall prescribe.

The undertakers may acquire lands by agreement and construct such works and acquire such licenses, patents, inventions, machinery, and apparatus, and enter into such contracts and do all such things as are necessary.

Any local authority which has obtained a license, order, or Act may contract with any company or person for the execution and maintenance of any works needed for the purposes of supplying electricity, but no local authority, company, or person can transfer to any other company or person, or divest themselves of, any powers given to them, or liabilities imposed by any license, order, or Act, without the consent of the Board of Trade.

The grant of a license or order to any undertakers is not to hinder or restrict the grant of a license or order to the local authority or any other company or person in the same area.

Certain provisions of the Gas Work Clauses Acts relating to the laying of pipes and other matters made applicable to electricity and wires are incorporated.

The undertakers are prohibited from placing any electric wire above ground, along, or over any street without express consent of the local authority.

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Where a supply of electricity is provided in any part of an area for private purposes, then, except in so far as is otherwise provided in the license, order, or Act, every company or person in that area is entitled to a supply on the same terms as any other company or person is entitled to a corresponding supply.

There are provisions for the protection of telegraphic lines of the Postmaster-General, and for relieving gas companies from the obligations to supply gas in an area where the Board of Trade considers that such an area is sufficiently lighted by the electric light and has ceased to be remunerative to the gas companies.

Section 27 of the Act of 1882 empowered the local authority within six months after the expiration of twenty-one years from the passing of the confirming or special Act, or such shorter period as is specified in any provisional order or Act, to purchase the undertaking upon terms of paying the then fair market value of all the lands, works, and plant of the undertakers at the time of purchase, due regard being had to the nature and their condition and state of repair thereof, and their suitability to the purposes of the undertaking, but without any addition in respect of compulsory purchase or of goodwill, such value to be settled by arbitration in case of difference. This section was repealed by the Act of 1888, but was re-enacted in substantially the same form, the term of forty-two years and subsequent periods of ten years being substituted for the term of twenty-one years, with power to the Board of Trade to vary the terms of sale in such manner as may have been agreed on by the local authority and the undertakers.

The Board of Trade have made rules under the Act of 1882 with respect to applications for licenses and provisional orders. The application is to be by memorial addressed to the Board of Trade, and the rules prescribe the form and contents thereof, description of area of supply, amount of capital, &c., the mode and form of advertisement, &c., and in the case of provisional orders the advertisements must be inserted in October or November, and the memorial must be lodged on or before December 21.

THE MAXIM-WESTON.

The Directors of the Maxim-Weston Electric Company, Limited, have issued to the shareholders a statement of the position of the Company's affairs, from which the following are extracts:

"No assistance was rendered to the new Directors by the Managing Director, Mr. Hugh Watt, or by any of the officers of the Company, and it soon became clear that it was quite impossible to carry on the business of the Company with the then existing officials. The Directors were on several occasions unable to obtain admittance to the Company's offices; Mr. Wright declined to fulfil his duties as secretary, and the clerks, though paid their salaries out of the funds of the Company, declared that they were in the service of Messrs. Hugh Watt and Co. On August 3 last the Board decided to have the affairs of the Company investigated, and the principal books were accordingly sent to the office of Messrs. Boyce and Ramsay, chartered accountants. On the same date Mr. Watt caused the books and papers remaining at the office to be sent to the Company's works, where they were deposited in confusion amongst the machinery. On the following day (August 4) Mr. Watt handed in his resignation, which was immediately and unanimously accepted. Mr. Wright, having refusing to obey instructions, was informed that his services as secretary would no longer be required. Mr. Samuel J. Boyce was then appointed Secretary of the Company, and, in compliance with Mr. Watt's request that the offices should be at once vacated, the registered offices were transferred to No. 2, Metal Exchange-buildings, Gracechurch-street, E.C. The Directors now feel that, by the exercise of energy and patience, the Company's affairs have been extricated from the confusion in which they found them, and they are enabled to lay before the shareholders a fairly accurate statement of the position of the Company. The Directors are also pleased to state that they have already effected a reduction in management expenses of over £1,000 a year. Notwithstanding the present unsatisfactory position of the Company, the Directors are strongly of opinion that with honest and attentive management a good and profitable business may be carried on. The Directors earnestly urge upon the shareholders the desirability of providing sufficient working capital for carrying on the business, as by that means alone can a new and prosperous business be developed. The Directors recommend that the capital of the Company be reduced by the cancellation of 2s. 6d. per share upon the existing 5s. shares, and that to provide working capital the 188,000 shares remaining unissued should be issued at 2s. 6d. each.

"From the accountants' report, it appears that the assets amount in all to £81,997. 16s. 5d., of which the chief item is £40,737. 1s. 1d. for patents. There is no sinking fund for the gradual extinction of this item, and the accountants are of opinion that the cost of experimenting should be paid out of revenue, and that the amount at which the patents are entered in the books should be subject to a depreciation of, say, £2,500. The stock has recently been re-taken at £19,817. 7s. 6d., and the plant and machinery revalued at £3,603. 15s. 2d., which, together with £228. 1s. 8d. for furniture and fittings, make up a total of £23,649. 4s. 4d. The new valuation made by the works manager, if taken as a basis, would make it appear that the value of the stock, plant, machinery, &c., at December 31, 1887, was about £14,950, instead of £23,649, as stated in the balance-sheet, making a difference of about £8,700, which is explained by comparing the stock lists. Of the sum of £15,001. 12s. 6d. owing from debtors, a large sum is represented by plant in the hands of agents, and a large proportion of the accounts not collected are in dispute. It is proposed to write off a sum of £7,600 against these accounts. In applying their estimate of the assets to the figures given in the balance-sheet at December 31, 1887, the accountants find that the assets are stated in excess of their value at that date to the amount of £17,445. Goods to the amount of £5,412. 10s. 5d. have been sent to various agents abroad during and since 1884, but only £699 worth have been sold. The amount of the reserve fund in 1885 (£3,606) was not made up, as it would appear, out of profits on trading, but was actually created by adding together the items for premiums on new shares issued and the balance left on the books after the reduction of the capital. During 1886 a sum of £2,074. 11s. 5d. was written off the agency accounts alone, and £1,531. 13s. 7d. from other accounts, and these two items together absorb the reserve fund of £3,606, which consequently did not appear on the 1886 balance-sheet. The reserve fund being utilised to reduce the amount appearing as book debts, the appearance of profit was maintained, and a dividend of 7½ per cent. was paid in March, 1886. A subsequent dividend of 5 per cent. was paid in March, 1887, out of the amount shown as profit in the accounts for the year 1886, no provision being made for loss on book debts during that year. From the foregoing it will be seen that the results of the trading have not been truly stated in the past by reason of the non-provision for bad debts, and by the over valuation of the stocks."

CITY NOTES.

Removal.—Messrs. J. H. Holmes and Co., of Newcastle, have removed their London office in Coleman-street to opposite their recent address.

Change of Address.—Messrs. H. Harrison and Co., electricians, have removed from 1, St. Swithin's-lane to 115 and 117, Cannon-street, E.C.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company for the week ending September 21 amounted to £4,956.

Telephone Company of Austria.—The Directors of the Telephone Company of Austria, Limited, have declared an interim dividend of 6 per cent. per annum on the preference shares for the six months ending the 30th inst., payable early in October, less income-tax.

Western and Brazilian Telegraph Company.—The traffic receipts of the Western and Brazilian Telegraph Company for the week ending Sept. 21, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Company, were £4,065.

Eastern Extension, Australasia, and China Telegraph Company.—The accounts of the Eastern Extension, Australasia, and China Telegraph Company for the half-year ended June 30 last show, subject to audit, a balance of profit of £79,153, after the payment of the interim dividend for the first quarter and charging the cost of the completion of the Singapore-Sagou cable renewal, amounting to £15,401. The Directors have declared a dividend for the quarter ended June 30 of 2s. 6d. per share, free of income-tax, payable on October 16 prox., and have decided to carry the balance of £47,903 forward to the next account.

General Electric Company.—We understand that Mr. Binswanger, of this Company, in conjunction with some of his friends, has acquired the works, plant, and patent of the Electric Portable Battery and Gas Igniting Company, of Chapel-street, Salford. The late Portable Battery Company from 1881, to the time of its liquidation, worked the patents of Mr. C. L. Clarke, of Manchester, for electric gas lighters. The works are also well known in the Northern counties as being one of the largest works in the district. They are to be entirely devoted to the manufacture of electrical apparatus. They have special facilities for making large quantities of electric gas lighters; but besides these it is intended to develop the manufacture of electric light fittings, electric bells, medical apparatus, &c. The works are also extensively fitted with wood-working machinery. These Manchester works will be carried on under the name of the Manchester Electric Works Company. We are glad to see that Messrs. Binswanger and Co. have so much enterprise in extending their sphere of operations, and we trust that the business will be entirely to their satisfaction.

Direct Spanish Telegraph Company.—The Directors' report states: "The accounts for the half-year ended June 30 show, after providing for debenture interest, a balance to the credit of profit and loss of £5,529. 19s. 4d. The traffic receipts show an increase of £851. 2s. 6d., as compared with the corresponding half-year of 1887. Both the Company's cables and the land lines in connection with them have continued in good working order throughout the half-year. The special wire erected by the Spanish Government between Bilbao and Madrid, referred to in the last report, has now been put at the Company's disposal for the exclusive use of their Bilbao cable traffic. In consequence of the fleets of several nations assembling outside Barcelona, on the occasion of the opening of the Universal Exhibition in that city by the Queen of Spain in May last, it was necessary to take special precautions for the protection of the shore end of the cable. The cost thus incurred, as well as that of the new cable house at Barcelona, is being charged to revenue. After putting the sum of £2,500 of the balance of profit and loss to the reserve fund, which now amounts to £11,028. 5s. 7d., there remains £3,029. 19s. 4d. Out of this amount the Directors recommend the payment of a dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 5 per cent. per annum (free of income-tax) upon the ordinary shares, carrying forward £274. 7s. 4d. to next account."

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PROVISIONAL PATENTS, 1888.

SEPTEMBER 15.

13,341. **Improvements in gas-batteries.** Paul Scharf, 115, Cannon-street, London. (Complete specification.)

13,342. **Improvements in commutator brushes or equivalents therefor.** John Vaughan Sherrin, 77, Chancery-lane, London, W.C.

SEPTEMBER 17.

13,402. **Improvements in the construction of secondary batteries.** Samuel Alfred Varley, 2, Hamilton-road, Highbury-park, London, N.

13,422. **Improvements in fire-damp indicators for mines.** James Pitkin, 6, Bream's-buildings, Chancery-lane, E.C.

SEPTEMBER 18.

13,473. **Improvements in and connected with electric primary batteries and motors, and in their application to launches and other vehicles.** John Sherrin and John Vaughan Sherrin, 77, Chancery-lane, London, W.C.

SEPTEMBER 19.

13,519. **An improved electric motor.** Francis Teague, Crown-yard, Stanhope-street, N.W.

13,529. **Improvements in electric meters.** Anthony Reckenzaun, Gray's-inn-chambers, 20, High Holborn, London, W.C. (Complete specification.)

13,530. **A combination switch-holder for incandescent lamps.** Claude Edward Sillett Gilbert, 79, Amhurst-road, E.

SEPTEMBER 20.

13,584. **Improvements in electrical tell-tales.** Emil Meyer, 62, St. Vincent-street, Glasgow. (Complete specification.)

13,598. **Improvements in electric motors.** Richard Richardson Hutchinson, 4, Little Moorfields, E.C.

13,615. **Improvements in or relating to cases for electrical batteries or cells.** George Bowen Satterlee, 169, Fleet-street, London.

13,621. **Improvements in electric meters.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London, W.C.

13,622. **Improvements relating to motors for the measurement of alternating currents of electricity.** Sebastian Ziani de Ferranti, 24, Southampton-buildings, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

JULY 16, 1887.

10,009. **Improvements in electric railway signals.** George Hamilton Wright, 45, Southampton-buildings, London.

SEPTEMBER 27, 1887.

13,080. **Improvements in and relating to dynamo-electric machines.** Waldemar Fritsche, 45, Southampton-buildings, London.

NOVEMBER 10, 1887.

15,385. **Apparatus for disinfecting impure liquids by electrolytic action.** Eugene Hermite, Edward James Paterson, and Charles Friend Cooper, 28, Southampton-buildings, Chancery-lane, London, W.C.

NOVEMBER 15, 1887.

15,660. **Improvements in electric clocks.** Apollon Joachim Thomas, 53, Chancery-lane, London.

NOVEMBER 14, 1887.

15,532. **Improvements in and relating to the use of electricity as a source of explosive power.** Samuel Joyce, jun., 113, Richmond-road, Dalston, London.

15,555. **Improvements in and pertaining to electric motors and their application for charging secondary batteries or accumulators.** William Morris Mordey, 46, Lincoln's-inn-fields, London, W.C.

15,583. **Improvements in electric tramways and railways.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Middlesex. (Thomas Alva Edison, United States.)

NOVEMBER 17, 1887.

15,801. **Improvements in incandescence electric lamps.** Wm. Henry Beck, 115, Cannon-street, London, E.C. (Auguste Marie Michel, France.)

NOVEMBER 26, 1887.

16,305. **An improvement in voltaic cells.** Henry Cornelius Donovan and Thomas Weatherall, 53, Chancery-lane, London.

NOVEMBER 30, 1887.

16,458. **Improvements in electric telephones.** Alan Archibald Campbell-Swinton, 75, Queen Victoria-street, London, E.C.

JULY 3, 1888.

9,662. **Improvements in or relating to electrical type-writers.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.)

JULY 31, 1888.

11,108. **Improvements in electric conductors or cables, and in means for preventing disruptive discharges therefrom.** Philip Middleton Justice, 55 and 56, Chancery-lane, Middlesex. (Edward G. Acheson, United States.)

AUGUST 7, 1888.

11,411. **Improvements in armatures for dynamo electric machines.** Alexander William Meston, 77, Chancery-lane, London, W.C.

AUGUST 15, 1887.

11,779. **Improvements in galvanometers.** Edouard Emmanuel de Facieu, 33, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1887.

11,543. **Electrodes for electric accumulators, &c.** H. Tudor. 8d.

12,414. **Electric arc lamps.** F. C. Phillips and H. E. Harrison. 8d.

12,763. **Electric meters.** G. Forbes. 8d.

13,853. **Telegraphic apparatus for transmitting orders, &c.** G. A. Calvert. 8d.

13,978. **Electric firing gear for guns.** A. Noble. 11d.

14,416. **Telephonic apparatus.** J. L. Corbett. 8d.

14,954. **Deposition, &c., of metals by electrolysis.** W. Terrill. 6d.

1888.

8637. **Electric clocks.** A. L. Parcelle. 8d.

10,631. **Electrical night signalling.** E. Kaselowsky. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	101
12 Feb.	1/2	Anglo-American Brush E.L.	4	3
12 Feb.	2/0	— fully paid	5	4
27 July	1%	Anglo-American	100	49⅝
27 July	2%	— Pref.	100	79¾
12 Feb., 85	5/0	— Def.	100	18
28 June	3/0	Brazilian Submarine	10	13¼
14 June	1/0	Con Telephone & Main	1	1/16
10 Aug.	9/0	Cuba	10	13¾x
10 Aug.	10/0	— 10% Pref.	10	19½
28 Mar.	2/2½	Direct Spanish	5	4⅛
28 Mar.	5/0	— 10% Pref.	5	10¼
27 July	2/0	Direct United States	20	10⅛
27 July	4/6	Eastern	10	12½
27 July	3/0	— 6% Pref.	10	15
1 Aug.	5%	— 5%, 1899	100	110
26 April	4%	— 4% Deb. Stock	100	108
12 July	2/6	Eastern Extension, Australasia & China	10	13
1 Aug.	6%	— 6% Deb., 1891	100	104½
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	103
28 Mar.	8/3	German Union	10	9½
10 Aug.	3/0	Globe Telegraph Trust	10	7¼
10 Aug.	3/0	— 6% Pref.	10	14½
30 April	5/0	Great Northern	10	14
30 April	5%	Gt. Northern 5% Deb., '83.	100	109
27 July	10/0	India Rubber, G. P. & Tel.	10	17¼
11 May	37/6	Indo-European	25	39
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	7/16
26 April	4/0	Reuter's	8	8
		Swan United		3½ 2¼
10 Aug.	13½%	Submarine	100	140x
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	8
1 Mar.	5%	— 5% Debs.	100	99
12 July	4/0	West Coast of America	10	8
30 June	8%	— 8% Debs.	100	115
11 May	9/0	Western and Brazilian	15	12¼
11 May	6/10½	— Preferred	7½	7 1/16
11 May	2/1½	— Deferred	7½	5½
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	1¾
30 May	10/0	— 6% 1st Pref.	10	12¼
13 May, '80		— 6% 2nd Pref.	10	9
2 May	7%	West Union of U.S.	$1,000	123
1 Mar.	6%	— 6% Sterling	100	105

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NOTES.

Motto for Promoters of Motors.—"So mote it be."

Court Theatre.—The Court Theatre just open is lighted throughout by electricity.

Lambeth.—The application of the Metropolitan Electric Supply Company has been referred to the Electric Lighting Committee of the Board.

Dover.—With reference to the proposed street lighting of Dover, the council have decided to obtain an estimate of the cost for themselves.

Electric Tramway for Gravesend.—An electric tramway, on the series system, is now being constructed near Gravesend, and will be working in December next.

Testimonial.—We notice that in Colchester a movement is on foot for presenting Mr. Paxman, who is mayor of that town, with a testimonial on the completion of the year of his mayoralty.

Light as well as Power.—The Daft Electric Company in many cases are making electric power supply the chief object; but also furnish electric light to the surrounding consumers.

Taking a Big Load.—One car on the Salem (Mass.) electric railroad recently took 110 passengers easily up a long hill, which has frequently compelled three horses to succumb with an ordinary load.

Tenders Wanted.—St. Stephen's Club requires current for 400 lights. Central station companies in London able to supply should look at the advertisement in our columns for tenders invited.

"High" Tension.—The Thomson-Houston International Electric Lighting Company are sending out an incandescent lighting plant for a mining establishment in the Andes, 14,700ft. above sea level.

Brussels Tramways.—It is the intention of the Brussels Tramway Company to extend, after thorough and complete experiment, the use of electric propulsion by accumulators to a large proportion of its cars.

Dynamo Struck by Lightning.—The aërial conductor of an electric railway at Frankfort has been struck by lightning. The flash ran along the wire to the dynamo, the armature of which it completely ruined.

Cable Repaired.—The cable of the Anglo-American Telegraph Company, laid in 1869, which was broken on the 23rd ult., at 135 miles from St. Pierre, in shallow water, was successfully repaired on the 30th by the company's s.s. "Minia."

Long-Distance Telephony.—Portugal is following suit with the long-distance telephony. The Portuguese Government has commissioned Messrs. Mourlon, of Brussels, to run a telephone line between Lisbon and Oporto, a distance of 200 miles.

Electro-Harmonic Society.—The concerts of the Electro-Harmonic Society will shortly recommence, and will be held on the last Friday evenings of the month at St. James's Hall. The first of the series will be a smoking concert on Friday, 26th inst.

Not Experimental.—The Thomson-Houston Company have 17 electric railways in daily operation. The Sprague Electric Railway Company, of New York, have 24 electric railways in operation or in process of construction in the United States. It is rightly stated that the work has passed beyond the experimental stage.

The Tesla Motor.—The Westinghouse Electric Company, says the *Electrical World*, are making some experiments with the new Tesla motor for street-car service, and are very much encouraged by the prospects. They propose to take up the matter of power immediately, and have this system of motors introduced as rapidly as possible.

Words from the Look-Out Man.—The demand for motors is increasing at a remarkable rate. Says an American contemporary, "In no other mechanical industry is the outlook so promising." One can hardly invent applications faster than we hear of the motors being applied to the purposes thought of. Central power supply is the coming boom.

The Wheeler Electric Regulator.—Messrs. Shippey Brothers, Limited, inform us that they have secured the European patents of Mr. Schuyler S. Wheeler's system for regulating electric motors for traction work, which is to be worked in conjunction with the Duke break and starter. It is thought that this will form a new departure in electric tramcar propulsion.

Lighting for Holborn.—At a meeting of the Holborn District Board of Works, on Monday, it was decided that the Metropolitan Electric Supply Company, the Electrical Power Storage Company, and the London Electric Supply Corporation, Limited, should be allowed an interview with the Works Committee with respect to the supply of electric lights within the district.

Leeds Fine Art Gallery.—The first permanent fine art gallery for Leeds, provided by the corporation at a cost of £10,000, was opened on Wednesday with a fine collection of pictures. The building is illuminated by about 1,000 Edison-Swan incandescent or glow lamps of 16 c.p. In addition, the central hall is to be lighted with six sunbeam lamps of 500 c.p.

Electric Light at Suakin.—The staff and crew of the telegraph ship "John Pender" are rendering valuable assistance to the Government at the siege of Suakin, and have displayed their electric light, thus keeping the rebels from extending their earthworks as before. Her officers and electricians are repairing the Government's electric light, there being no one here capable of doing the work.

New Central Stations.—We understand that the Anglo-American Brush Electric Light Corporation are taking steps to establish a central station at Bournemouth for the supply of electric light. It is also understood that the Brush Corporation contemplate the establishment of central stations at other places in the provinces, where they have for some time past been pushing the interests of electric lighting.

C. and C. Motors.—Mr. Shippey is distributing some very beautifully got-up catalogues of the C. and C. motor, which is said to be making things "hum" generally in the States. Illustrations are given of motors adapted to arc light circuits and to incandescent circuits, for fans, pumps, organ-blowing, post office stampers, and sewing-machines, and for all sorts and conditions of purposes generally for small motors.

Crime and the Electric Light.—In a letter to the *Times* with reference to the recent outrages in the East End, Mr. Morton Latham writes: "It was estimated in

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New York that every street electric lamp saved one policeman and was less expensive to maintain. If every street were well lighted, and every court and alley were brilliantly lighted, deeds of darkness would be diminished and morality promoted."

Reporting Progress.—The Whitehall Court installation is approaching completion. The cable to the Avenue Theatre is now laid. The boilers and engines are practically ready, though the battery of accumulators is not likely to be fixed for some little time, and the dynamos will be run direct at first. A trial of one of the boilers was made yesterday afternoon, and lighting will probably be commenced with one dynamo in a few days.

Proposed Electric Tramway in the New Forest.—A proposal has been made to the Highway Board at Lyndhurst, on behalf of Messrs. Haines and Poole, engineers, to construct an electric tramway between Lyndhurst-road station and Lyndhurst. The proposal was not well received by the board, who thought it would destroy the glory of the forest, and be an element of danger. A resolution objecting to the scheme was carried.

Electric Baking.—It is said that Mr. George Stewart, F.C.S., chemist to Messrs. J. and B. Stevenson, the extensive bakers, of Glasgow and London, who has been experimenting during the last twelve months with the object of discovering a method of baking bread by electricity, has been quite successful after a great deal of labour. The bread is said to be quite as well baked as by the present methods and more quickly, and it is stated that there will be a very considerable saving in expense.

Metropolitan Lighting.—The Metropolitan Board of Works has resumed its sitting. A letter was read last Friday from Messrs. Bircham and Co., on behalf of the Metropolitan Electric Supply Company, stating that they intended to apply to the Board of Trade, under the Electric Lighting Acts, 1882 and 1888, for a license authorising the company to supply electricity for lighting and other purposes within the area described in the plan accompanying the letter. This letter was referred to the Works Committee.

Brushes Wearing.—The cause of brushes wearing rapidly is often due to the nature of the brush itself, when the fault is thought to be in the armature. The more points of contact the less sparking, is the rule. If, therefore, a dynamo sparks, or the commutator burns away, try the substitution of brushes made of finer wire, or of wire gauze. Cases have been known where the brushes have worn two or three times as long, and the commutator kept perfectly smooth by substitution of fine wire brushes in place of those of the copper ribbon type.

Traction-Increasing Apparatus.—Mr. Elias E. Ries has made arrangements with an American railway for the equipment of their steam locomotives with his electric traction-increasing apparatus, which is to receive a thorough practical test in regular service. Mr. Ries claims that by the temporary molecular action at the points of contact of the wheel with the metals, due simply to the passage of a low-tension current, a 40-ton engine will work with the tractive power on the rails equal to that of a 60-ton engine. The application bids fair to greatly increase the carrying power of existing railways.

New Lamps from Old.—Mr. Arthur Shippey has shown us an incandescent lamp constructed from the remains of old Edison lamps. The platinum and glass pieces are taken just as they are, and remounted with filaments made out of old filaments reground, or in some cases, when broken near to the point, simply jointed again to the platinum and marked at a lower voltage. A fresh globe is blown round this resuscitated arrangement, and the cost of repairing is said to be nominal. The carbon of the filaments after long burning is found to be very hard and dense, and of closer quality than when first made.

St Albans.—The gas company in St. Albans has a monopoly of lighting, and Councillor Westell thinks the time has come when electricity should step in and cut them out. At St. Albans, he said, the river could be employed to generate more power than the city would consume, and he moved that the council take the matter up, and prevent the powers getting into the hands of monopolists. Enquiries were made some years ago, but the electric light was much less expensive now. The resolution was agreed to, and enquiries are to be made at once. We may, perhaps, be seeing St. Albans lighted before long.

Aluminium Alloys.—The new metal aluminium is largely useful for the improvement of foundry castings. The addition of ten pounds per ton to molten iron renders it almost free from blow-holes, and increases its tensile strength by one-half, besides which it makes the castings much better and sharper. The loss by bad castings in foundries is continual, and, as one firm puts it, "one pound of bad castings takes the profit off eight pounds of good castings." The introduction of this metal will, therefore, prove a good boon in foundry practice, the price of aluminium, as produced by the recent electric processes of heating the metal, being quite within reach for this purpose.

Old Students' Dinner.—We wish to remind our readers that the fourth annual dinner of the Old Students' Association of the City and Guilds of London Technical Institute will be held at the Holborn Restaurant on Saturday, October 13, at 7 p.m., under the presidency of Mr. Pettigrew, of the London and South-Western Railway, Nine Elms, past student of Finsbury. Dr. Silvanus P. Thompson, Profs. Perry, Ayrton, Meldola, and others are expected to attend, and an interesting *réunion* may be expected. Tickets (to all interested), price 4s. 6d. each, can be obtained of the hon. sec., Mr. John Rance, jun., 1, Turret-grove, Clapham, or of the Sergeant at the Finsbury College, and a few tickets are to be obtained at the office of this paper, 139, Salisbury-court.

Last, but not Least.—When electric light was first introduced it was thought arc light supply on the high-tension alternate-current system would be the staple electric industry in the future. But ideas change. Incandescent lamps being invented, the 16 c.p. lamp on the low-tension system was now to be the chief work of electrical engineers. But transformers came forward, and the alternate-current is knocked down only to come up again with twice the strength. Motors now gain the attention of the world, and truly the latest comer, like Joseph's sheaf, will be bowed down to by the older ones. In this, also, the alternate-current is not left, but immediately adapts itself to all circumstances and every demand. Let us hope electrical engineers will do likewise.

The Storage Cars in New York.—A very successful trip was made on Saturday, September 15, by the first of the ten new storage cars, of the Julien system, built to run on the Fourth Avenue Railroad,

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New York. The cars are the most massive and handsome that have ever been put on street-car lines, the interiors being finished in carved hard woods and the windows being of bevelled plate glass. The cars are 18ft. long, and have two four-wheeled trucks, each carrying a motor. The cars weigh altogether between eight and nine tons, and are provided with an equipment of 144 cells of Julien battery of a weight of 4,200lb. The car travelled with the utmost smoothness, and, whenever the track was clear, made a speed of 10 miles an hour.

University Extension Lectures.—A series of 10 lectures in connection with the London Society for the Extension of University Teaching will be given at the Chelsea Town Hall, by W. Lant-Carpenter, B.A., B.Sc., on "Electricity in the Service of Man," on Fridays, at 8 p.m, commencing October 12th. The lectures will be illustrated with experiments and lantern photographs, and will be in the following order: Electrical Energy and its Uses; the Voltaic Battery; Electro-plating, &c., and Accumulators; Magnetism, Induction, Transformers; the Dynamo Machine; Electric Heating, Furnaces, Welding; Electric Lighting; the Electric Telegraph; the Telephone and Fire Alarms; Transmission of Power. The price for the course is four shillings. The inaugural lecture, on October 12th, will be free.

Electrical Action of the Heart.—The most important of the inaugural addresses at the hospitals was Dr. Waller's at St. Mary's on his discovery of electrical currents caused by the pulsation of the human heart. The researches which Dr. Waller described have occupied him during the last four years; and the record was interesting, he thought, as an actual example of what goes on in physiological laboratories and a correction of "that most unfortunate and mischievous error that they are chambers of horrors." But more interesting still are the results of the researches themselves; for if in each human heart there be indeed a latent electrical battery, then developments in the art of electricity may in time become possible beside which even Mr. Edison's wonderland will seem commonplace.—*Pall Mall Gazette.*

Examination at Prince's Street.—The following gentlemen recently obtained certificates as the result of the examination conducted by Mr. H. R. Kempe, of the Engineer-in-Chief's Office, G.P.O.: F. Thomson, 99 per cent. of full marks, E. M. Blakeley 97, H. F. Langton 87, W. N. Legge 86, W. W. H. D'Aeth 85, H. C. Hodges 83, F. A. Pocklington 82 per cent. No certificate is granted for less than 70 per cent. of full marks, and the candidates had also to satisfy Mr. W. W. Beaumont as to their knowledge of steam engineering. The scheme of instruction of the advanced class has been reorganised under the auspices of the new senior instructor, Mr. Chas. Capito, M.I.M.E., &c., with the view of meeting still more completely the requirements of the profession. Some of the above gentlemen have already obtained appointments.

Lighting of Stroud.—A ratepayer of Stroud has recently suggested the lighting of that town by electricity by means of the water and steam-power in the neighbourhood, which is abundant, and could easily be utilised. He suggests the spreading of the lighting over the district by means of dynamos in the various mills and breweries, which should light the public ways while illuminating their own factories. It is not altogether evident that the suggestion would be the best means possible of tackling the problem in Stroud, but the suggestion gathers weight from the fact that the little town of Wickwar, near Stroud, of about 1,000 inhabitants, has just been lighted in this manner from a dynamo machine in the neighbouring brewery. Many little towns might be lighted in this way; there are often owners of factories with spare boiler-power who might be induced to introduce the light, forming it into a local company when sufficient private custom was obtained.

Light Efficiency of Lamps.—In view of the recent suggestive papers contributed by Prof. Oliver Lodge upon the actual production of light energy, the statements of Prof. Ernest Merritt, of Ithaca, N.Y., will be interesting. Prof. Merritt has made experiments to determine the efficiency of an incandescent lamp considered as a light-making machine; that is to say, the ratio of energy given forth as light compared with the electric energy absorbed. This efficiency is found to be very small, for ordinary 16 c.p. lamps it is only about 4 to 6 per cent. If an incandescent lamp could be made perfectly efficient, it would therefore give the same amount of light at less than one-tenth of the present cost. The quality of the light from different lamps and from the same lamp under different circumstances is found to vary. In some cases a much greater amount of energy is needed to make the same impression in the eye. The experiments were made in the laboratory of Cornell University and will be continued.

A Submarine Torpedo Boat.—Experiments are being made on the Seine, near Issy, with an electrical and submarine torpedo boat made for the Minister of the Navy, and at his own expense. This engine of war is constructed of sheet-iron, shaped like a cigar, having a length of four metres fifty centimetres, and a diameter of one metre sixty centimetres. Its electrical current is generated by Schanschieff's bisulphate of mercury batteries, which have the advantage of not being liable to rapid exhaustion, and have more force than any other kind. The motor is a dynamo of Edison's of a new sort—light and compact. This boat can be made to dive and take an undulating course in the water. Large scissors project from the prow, which are intended to cut torpedo wires. They are worked by machinery from within. Compressed oxygen is stored in tubes of peculiar construction, and in sufficient quantity to make it easy to keep the boat some time under water. This model has been obtained from Russia. It was adopted by the Russian navy a short time ago, after it had been tested at Cronstadt.

Lighting of Wickwar.—On the 2nd inst. the town of Wickwar, near Stroud, was lighted by electricity by a somewhat novel arrangement. Last winter Messrs. Arnold, Perret, and Co., Limited, having decided to light their extensive brewery at Wickwar by electricity, offered the town a circuit from their dynamo, and this the town committee gladly accepted. The trial run, which lasted two hours, was pronounced a decided success. Fifteen lamps are used in the street of 32 c.p., Edison-Swan incandescent, and the furthest is three-quarters of a mile from the machine. The lamps are arranged two in series, and bare wires are run through the streets on poles. The Phœnix Fire Office rules have been carefully observed throughout the whole installation, which consists altogether of 120 lights, and the motive-power is derived from a large overshot water-wheel, 36ft. in diameter. The dynamo is one of Messrs. Elwell-Parker's shunt-wound, giving 200 volts at 550 revolutions. The whole of the work has been carried out by the brewerymen and the local tradesmen,

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under the direction of Mr. F. Graham Ansell, formerly of London (Guilds' College, &c.), the electrician to the brewery.

Catalogue of the Series Traction.—We have received the catalogue or prospectus of the Series Electrical Traction Syndicate, Limited, 11, Queen Victoria-street, and notice that the list of directors includes one of the directors of the Woodhouse and Rawson Co. and Lord Crawford. Photographs of the series system in operation are given, and mention is made of a tramway on this system, now in course of construction. Tables of figures are given, showing the advantages of the series system. We have little doubt that the series method of traction has an immense field before it, and the figures given go to prove the advisability of using motors in series on long lines. But we doubt the expediency of submitting to engineers as a simple statement one which is certainly not applicable in all cases, and must vary according to the size of conductor employed. "A conductor with a resistance of 0·15 ohms per mile is used . . . . efficiency of parallel system, forty cars, 9 per cent.; efficiency of series system, forty cars, 99 per cent." Promoters of the parallel system would certainly not use a cable giving only 9 per cent. efficiency, and the mere comparison in this manner is, to say the least, unwarranted.

Electrically Refined Sugar.—With regard to the recent exhibition of samples of sugar alleged to have been refined by electricity, the following letter has been addressed by Dr. Silvanus P. Thompson to the editor of the *Times*: "Sir,—In these days, when the mere prefixing of the word 'electrical' to a process or invention is sufficient to attract attention on the Stock Exchange and in the public press, it may not be unimportant to point out that the persons who have introduced into this country samples of sugar refined by the method devised by the late Mr. Friend, of New York, have produced no evidence whatsoever that electricity has anything to do with the process. The chemistry of sugar refining is briefly this—that the syrup requires to be partially oxidised and strained or filtered to free it from impurities. Far be it from me to deny that oxidation can be effected by electric discharges. Granted that this can be done as a matter of experimental science, there still remain three questions—Can the process be made a commercial one? Is such a process cheaper than the older chemical processes for attaining the same end? Lastly, but not of least moment, have the samples of 'electrically refined' sugar been, in fact, produced in this way? I am aware that a certain section of the public prefers to take such matters on faith. As a scientific man I must be permitted to be sceptical until proof is forthcoming."

Used in One Hundred and Twenty-eight Industries.—The electric motor is making extraordinary way in everyday use in America, and bids fair to rival the progress of the electric light. We give this week a very practical paper upon the uses that the electric motor is put to, showing the basis upon which motor charges are to be calculated. In Chicago the motor is used for all and sundry purposes in 128 different industries. Its advantages are obvious, and we wait only for power stations to hear of its spread in England. Says one of the enthusiastic motor men: "It will hoist anything from a dumb waiter to a ten-ton granite block; will operate a sewing-machine as well as an elevator; polish a tooth or bore a gun-barrel; turn millstones or a lady's fan; make a cigarette just as well as a sausage; blow the organ, roast pea nuts or coffee, churn the butter, cork bottles, black shoes, pump water, and test oil. It is, in fact, calculated to relieve poor suffering humanity of many of its woes. In many business houses ventilating fans have already been introduced. The motor that runs them is of one-eighth h.p. The fan itself is a six-winged affair of copper, bright and shiny as a brand-new coin. It is placed on the desk and keeps the air cool and pure while it drives away the flies. A 2 h.p. motor is used at the fire brigade station to run all the machinery for repairing the fire-alarm apparatus. A 2 h.p. motor grinds a coffee-mill. A gun-shop uses one for boring, turning and polishing. In one building there are two 10 h.p. electric motors operating huge fans, and one 5 h.p. No elevators are run as yet by electric motors, but the cause of this is simply that there has been not enough current. Two doctors use them for dental purposes, and several hardware stores use them to grind knives and scissors. The electric motor is making things hum, but a short time must elapse until the cheery note of the motor song will be heard as plentifully as the chirp of the sparrow on our public thoroughfares."

Watchman's Register.—A new watchman's register has been invented by Mr. Henry Boardman, of Bradford, for recording, by electricity, the visits of watchmen to various departments of extensive premises. At each room or station to be passed by the watchman on his round an ordinary bell-push or button is fixed and connected with the time register, which is fixed in the private office or any other suitable place and securely locked. As the watchman makes his round he has only to press the button and the visit is recorded in the private office by a very legible punctured hole in the register-paper, there being a separate column for each room. In the morning the principal or manager can see at a glance the number of times the watchman has been at the several stations during the previous night, together with the exact time at which each visit was made; and should the watchman neglect some stations, or attend to some more than others, it would be very distinctly shown on the register. Messrs. Samuel Smith and Co., Limited, Horton Dye Works, have had one of these registers working for three or four months with such satisfactory results that it is intended to enlarge the apparatus, so as to cover the whole of their large works. To enable a continuous supervision to be maintained, a double check is introduced, so that if the person appointed to see that the watchman attends to his duties fails in his supervision, the fact is as plainly evident as is any neglect by the watchman, and is as equally ineffaceable. Another and a very important feature of the invention is that records can equally well be taken for Saturday afternoon, Saturday night, the whole of Sunday and Sunday night, thus getting a complete register for the whole week. The apparatus is very simple, as well as effective. The broad belt of paper on which the record is made travels over an inch each hour, so that there is more than a quarter of an inch space between every quarter of an hour. Each paper will last for a week or a fortnight, and the apparatus can be easily arranged to go on for months without a change. The papers taken out of the register can be kept as permanent records.

Electric Lighting in the City.—The Anglo-American Brush Electric Light Corporation have resumed their negotiations with the Commissioners of Sewers with a view to the lighting of the City of London, and in connection there with they have prepared for private circulation a memo

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randum setting forth the circumstances attending the past negotiations. In connection with the epidemic of crime in London which at present prevails, they remark that in the United States, where the electric light has been largely adopted for the streets, the police officers testify to its utility in the prevention of crime and the protection of life and property. On the general question of the development of electric industry they make this important observation: "Hitherto England has taken an important part in, and derived enormous benefits from, the industrial advance of other countries; but, in regard to electric lighting, the public at home have not only been deprived of the use of improved methods of lighting, but English manufacturers and contractors have on the Continent been forestalled by foreigners — not because they have lacked capacity to do the work, or enterprise or energy to initiate it, but because they have been unable to produce evidence that their systems have commanded support at home, where they should be better known. It was English people who carried out most of the important gas works on the Continent; and they were able to do so because the gas industry had been fostered and encouraged at home. Electric lighting, on the other hand, which at best has an uphill battle to fight, has been hampered by the Legislature and discouraged by the municipalities. The Brush Corporation, therefore, speak in the interests of an industry which, under favourable conditions, promises to assume considerable dimensions, in urging on the Commissioners of Sewers of the City of London that this opportunity may not be lost of bringing to an issue the experiments and negotiations which that body so long ago initiated and have encouraged in the past, and of showing what can be done under methods approved and controlled by their own advisers."

Society of Arts Engine Trials.—The trials of prime motors, undertaken by the Society of Arts, are likely to prove both successful and unsuccessful—successful by reason of the completeness of the means of testing adopted in every detail, but unsuccessful because of the fewness of competitors. It is certainly remarkable that on these trials, which, without doubt, might be considered as likely to be productive of accurate and permanent results, only one firm of steam-engine makers, Messrs. Davey, Paxman and Co., submit a steam-engine, and the only other branch of prime motors represented is that of gas-engines, in which Crossley's Otto, Atkinson's Cycle (British Gas Engine Company), and Griffin's (Dick, Kerr and Co.) gas-engines are submitted for trial. Four gold and four silver medals were offered, and all prime movers, steam, gas, air, or water, &c., were practically open. The trials are conducted under the superintendence of Prof. Kennedy, Dr. Hopkinson, and Mr. Beauchamp Tower, at South Kensington, on the ground shortly to be used for the Imperial Institute. The Davey-Paxman engine is a compound portable, indicating about 20 h.p. at 180lb. pressure. Very elaborate tests were taken, the details of which will be worked out and published. The engine was fired by Mr. Paxman himself. Special meters are fixed in conjunction with the gas-engines, and rope brakes are used in both cases. Every precaution is taken to ascertain the losses in heat in casting and in gases. To measure the actual variation of speed at every stroke in the gas-engine a very ingenious speed counter was employed, devised by Mr. H. B. Ransom, one of Prof. Kennedy's pupils. This consists of a 6in. drum, rotated by the engine shaft. Blackened paper is coiled upon this drum, and a stylus pressing upon the paper makes a spiral line as the drum revolves. This stylus is carried upon a tuning fork, which can be set in motion like the vibrator of a Rhumkorff coil by a make-and-break contact actuated by a battery. The line then becomes serrated, and the number of serrations can afterwards be accurately counted. The speed of vibration of the tuning fork is constant, and as the speed of the gas-engine varies, the number of serrations per revolution gives an accurate record of the speed of the engine, not only per minute but the variation in each revolution.

Velocity of the Electric Current.—At the recent meeting of the American Association for the Advancement of Science, at Cleveland, Profs. E. L. Nichols and W. S. Franklin, of Cornell University, presented a very interesting paper on "The Direction and Velocity of the Electric Current," of which the following abstract is given by the *Electrical World*: "A coil of wire of 390 turns was driven at a very high rate of speed, the axis of the coil being the axis of rotation. When the coil reached 338 revolutions per second, the linear velocity of the wire in the direction of its own length amounted to 8,000 centimetres per second. By means of two brush contacts at the axis a current was sent through the coil while the latter was in motion. The magnetic moment of the coil was determined by means of a very sensitive astatic pair of magnets carrying a mirror. Readings were taken with the coil at rest and in revolution, the motion of the coil and the direction of the current being repeatedly reversed. If the electric current result from the flow of a fluid through the wire, in other words, if it may be considered as possessing direction and finite velocity, the influence of a motion of the conductor, with or against the current, should produce an appreciable influence upon the deflection of a magnet needle, even though the velocity of the current were very large as compared with that of the conductor. In order to render the detection of this presumably very small effect less difficult, the direct influence of the coil was eliminated by differential winding. Under these circumstances, when the coil was carrying as large a current as it could be made to do without injurious heating, the rotation of the coil was found to be without appreciable effect upon the magnetic moment of the same. The best results were obtained by sending 4·6 amperes of alternating current of 40,000 alternations per minute through the coil. At a velocity of the wire equal to 8,000 centimetres per second they produced an effect upon the needle amounting to 0·2 millimetre deflection. The figure of merit of the coil and needle was determined by substituting a coil of continuous winding, its position with respect to the needle being the same as that of the rotating coil, and determining the current necessary to produce one centimetre deflection. The sensitiveness of the apparatus was found to be such that a current having direction and a velocity of 1,000,000,000 metres per second would have shown a change in its action upon the needle (when the motion of the coil was 380 revolutions, 8,000 centimetres per second), amounting to 0·1 centimetre deflection, an effect which could not have escaped observation. It follows from the above negative result that if the electric current consists in the flow of a medium or fluid through the conductor, the velocity of the same must be greater than the exceedingly high rate just mentioned. Foppl, who in some recent experiments (*Weidemann's Annalen*, 1886), using an apparatus in most essential particulars similar to our own, but one by means of which only relatively very low velocities could have been detected, has reached the same negative conclusion."

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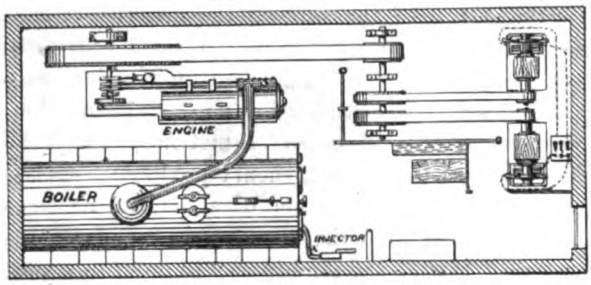
LEAVES FROM THE DIARY OF A YOUNG ELECTRICIAN.

BY BROAD BENT.

(Continued from page 265.)

August 2.—London is famous for many things—*inter alia*, the hardness of its water. This feature is not very highly appreciated by the users of boilers, as by causing a bad heat conducting deposit to form in the latter, a greater quantity of coal per h.p. is consumed than would be necessary with a clean boiler. Many compositions, in the shape of "boiler pickles," are used, which are guaranteed to remove all incrustation, and to effect a saving of 20 per cent. and more in the fuel consumption; but there are few, if any, entirely satisfactory. Whilst some attack the boiler-plates, others choke the valves or destroy the packing of glands, and others, unless used in such large quantities that either the price is prohibitive or the engines prime badly, are of very little use. Although we use one of the best of these "pickles," we find it necessary to wash out the boiler once in every three weeks, each time taking out about a hundredweight of hard scale and chalky sediment. The two men on night work have the "washing out" to do between the hours of one and six on Sunday morning, which is not a bad five hours' work; then steam is got up, and the engine started again by half-past seven.

It is, of course, impossible to keep one set of machinery running year after year with never more than seven hours' stoppage,* so we are allowed one week annually "to overhaul the plant," and to do all necessary repairs.



Plan of Engine Shed.

This took place last week, when the boiler and feed-tank were chipped, all valves cleaned and ground in, injector overhauled, piston rings examined and adjusted, excentric straps and brasses reduced, main belt taken up, new pump ram put it, slide valves and ports examined, bottom and side flues of boiler cleaned out, and many other little jobs. Altogether, it was a fairly good week's work for four men. Had there been sufficient time it would have done the ports and slide valves good to be faced up, but these will now have to wait till next year. It was rather a joke to walk through the stations whilst the repairs were going on, as the gas not having been used for almost a year, half the burners would not light, and others were so corroded that the light was "all over the place." The very men who had been so persistent in their malevolent attacks upon the electric light were those now most anxious to have it again.

August 3.—Shortly after we—the day shift—came on this morning, the engine began to make a terrible jarring noise, which for some time we were quite unable to understand. At first we thought it might be the pump, as that has a bad habit of being noisy at times; but as the noise continued whether the pump was feeding or not, we dismissed that idea. The next likely thing was the big end of the connecting rod, but that also was all right. Another circumstance which puzzled us quite as much was that, with the regulation valve "full open," the engine was barely running at the usual speed, whereas at other times it would have been too fast under such conditions. Eventually, we found the cause to be in the excentric strap which is connected to the slide valve rod. The check nuts having worked loose and run back as far as the split pins in the bolts, about a quarter of an inch play was left between the strap and the sheave, which caused a double knock in every revolution, and, by reducing the travel of the slide valve, tended, of course, to cause the engine to run slower. As it was not possible to tighten the nuts whilst in motion—I cut my fingers badly in the attempt—we had to put up with this unmelodious jar all day.

August 16.—I have just read of a device for automatically shifting the lead of brushes on dynamos supplying very variable currents. This reminds me of a device—not automatic—that I once saw in connection with a dynamo working an electric tramcar at an exhibition. The arrangement consisted of a small boy seated upon a low stool beside the commutator, with one hand on each handle of the brush carrier. Whenever the brushes flashed, he knew that the load had altered and that he must shift the brushes. If the car was rounding a curve or mounting a gradient, the load would be greater and a forward lead required. If descending or stopping, the brushes would require, of course, to be put back. Now, this small boy arrangement would have been all that could be desired had he only known which way to move the brushes, but when I saw him—poor little fellow—he seemed to be in a hopeless state of confusion, and was moving the handles backwards and forwards in a most excited manner. Whilst I stood there, watching and pitying him, a man came up and asked him what the "dickens"—or words to that effect—he was up to, as the car full of passengers was "stuck" in the middle of the track. On the whole, I think the automatic arrangement would have been an improvement.

August 28.—"Is an E.M.F. of a thousand volts dangerous to life?" This question is causing a lot of discussion now, to what purpose I do not know. When eminent professors say it is not, it would be great presumption on my part—cheek, some people call it—to say anything to the contrary. However, I may tell my diary on the Q.T. that I would not like to risk it. I make a simple proportion sum of it thus: "If 160 volts almost throws me off a ladder, whereby I might be run over by a train and killed, what would 1,000 volts do?" Just for my own satisfaction, I a few days ago placed my hands on the terminals of our dynamos—that represents about 170 volts—to see what would happen. All that happened was that I removed my hands again without having felt the least unpleasant sensation. A few hours later I had occasion to adjust the brushes. To perform this operation nicely, it is customary to stoop down, balancing oneself on the tips of one's toes, which is a position of very unstable equilibrium. Thoughtlessly I touched both brushes at the same time, with the result that I received a sharp shock, and, losing my balance, toppled over against the wall. Now, it was not the shock that knocked me down, but the rapidity with which I took my hands off the brushes. The reason I felt the shock so plainly was that I had just washed my hands, hence, my skin being damp, had a comparatively low resistance.

The machineman informs me that in passing the switchboard a short time ago he accidentally placed his bare arm against the terminals, with the result that he was thrown against one of the dynamos. A red mark was left on his arm where one of the bars touched as though something hot had touched it. He also says that he felt sick for the rest of the day, but this may have been only an effect of the fright and not of the current.

What really prompts me to notice this in my diary is, that yesterday, in putting a safety-fuse in a lampholder, I got such a shock that I almost lost my balance on the top of a pair of steps, and it was only by seizing a gas-pipe that I escaped falling on the metals. From my own observations I am inclined to agree with those who maintain that it is impossible to say what E.M.F. really is dangerous. It is about as correct to say that an E.M.F. of 1,000 volts is dangerous to life, as to say that a current of 1,000 amperes will fuse a conductor without giving any dimensions or other particulars of the latter.

September 1.—For several months I have been in the habit of reversing the leads once a week, with the idea that the change in the direction of the current would prolong the life of the lamps, but results seem to indicate an opposite effect, though I know of no theory in support of such a result.

I have noticed that always on the day after reversal, the number of lamps replaced through broken filaments is two

* The seven hours' stoppage is every Sunday morning as above; on week-days we stop from 1 a.m. till 5.30 a.m. only.—B. B., 1888.

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or three times the daily average. To make sure that this is not a series of strange coincidences only, I have altered the day of reversal several times, and also left the leads two and three weeks together in one position, but the result is always the same on reversal, and, in spite of the absence of a theory in explanation, I have now ceased changing over the leads.

Whilst on this subject, I am reminded of a note I saw recently on the "Extraordinary Life of Incandescent Lamps," in which some lamps were said to have had the extraordinary life of 6,000 hours. To my mind, there is nothing very extraordinary about it, except that anyone who calls himself an electrician should speak of the life of a lamp in this way without some statement as to the number of watts absorbed per candle-power.

There are lamps burning now on this installation which have been up for over a year. This, at twenty hours a day, means over 7,000 hours, and there is no reason why they should not burn for many a long day yet under the same conditions. They are called 160v. 16-c.p. lamps, which is doubtless perfectly correct when sent from the makers; but to call some of them 16 c.p. now, even if supplied with current from 170 volts, is a gross insult to the much despised "dip." When first put up they are all right; in a fortnight, perhaps, they give 12 c.p.—certainly not 16; in a month, not so much. Of course, *some* keep up to the mark, but not for *6,000 hours!*

The cause of this falling off in luminosity is twofold:

1. Owing to the imperfect vacuum in the lamp, the filament gives off very minute particles of carbon, which, being deposited upon the inner surface of the glass, decreases its transparency.

2. The consequently higher resistance of the filament.

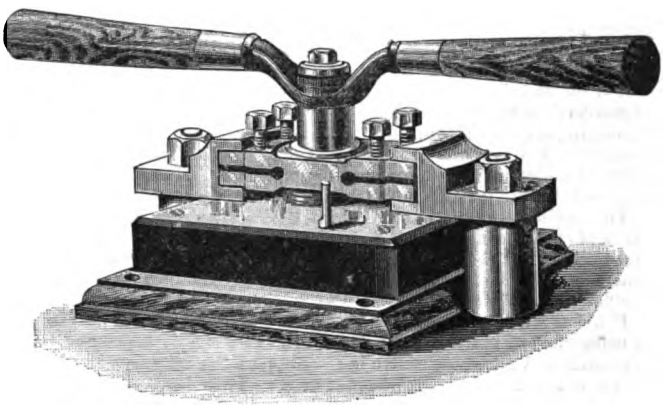
It has been suggested by a Mr. Lucas that some absorbent be introduced into the lamps to prevent this dullness. In a communication to the Academy of Sciences, Mr. Lucas say: "I have endeavoured to determine the true cause, and my experiments prove that it consists in the presence of molecules of oxygen within the lamp. We find, in fact, that the rate of increase of the deposit is in direct relation with the pressure of the internal gas. A molecule of oxygen not removed combines with the carbon near its junction with the metallic conductor, a region at which the temperature cannot reach the melting-point of the conductor. There is thus formed a molecule of carbonic oxide. This molecule, then, coming in contact with the incandescent portion, the temperature of which is high enough to produce dissociation, projects the carbon against the inner surface of the glass globe, and leaves the oxygen to combine again."

This sounds very nice and may be the true scientific explanation; but if "incandescence" means "white heat," I do not think it is a necessary condition. There are lamps on the stations which have never been "incandescent" since they left the photometer-room, but which have, nevertheless, blackened. It is only a matter of time with them. However, I quite agree with the conclusions of this theorist, that the more perfect the vacuum, the less the blackening of the bulb. One can generally tell if a lamp will blacken quickly or not by the temperature to which the glass rises when the lamp is burning, as this is also a rough indication as to the state of the vacuum.

(*To be continued.*)

ADJUSTABLE SWITCH.

We herewith illustrate an adjustable switch manufactured by Messrs. Appleton, Burbey, and Williamson, and designed with the view of meeting the increasing demand for trustworthy and durable articles of this kind. It is important that the accessories of every electric light and power installation should be suitably designed for the purpose they have to fulfil, and carefully made so that no injury or accident is likely to arise from ordinary usage. In the switch illustrated, which is intended to carry 1,000 amperes, the ends of the levers are slotted, the adjustment being regulated by means of set screws, thus obtaining thorough contact and avoiding heating. Large and ample contact surface is provided in the switch illustrated by 2·5 square inches. The contact surface is enlarged in switches required to carry greater current. The switch is mounted on slate or china bases as required, and fitted with or without spring throw-off. It is a good sign

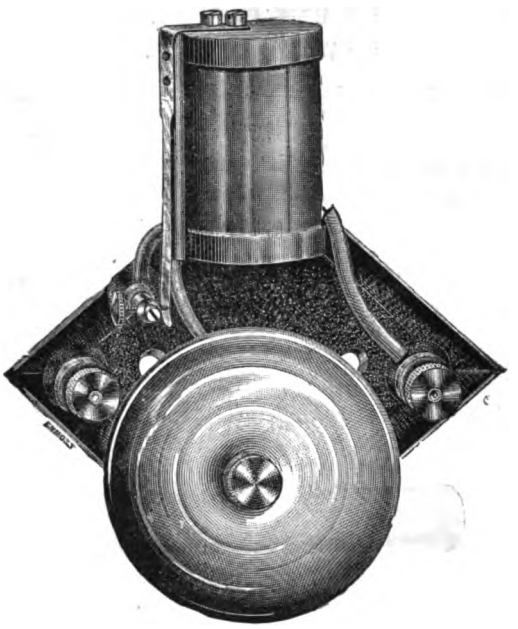


New Adjustable Switch.

that so much attention is being paid to their details, as success depends very much upon them, and loss by breakage is avoided.

THE "DIAMOND" ELECTRIC BELL.

There is a good demand for a really useful and cheap form of electric bell for ordinary use in houses, and for telegraphic and business call bells. Several forms have been brought out from time to time, but one of the best of the cheap electric bells is the "Diamond," lately introduced



The "Diamond" Electric Bell.

by the Woodhouse and Rawson Electric Supply Company. It has a very neat appearance as shown in the accompanying cut, and is a reliable and useful little piece of apparatus. It should command a ready and extensive sale.

REGULATING ALTERNATING CURRENT DYNAMO ELECTRIC MACHINES.

BY W. LOWRIE.

Hitherto the great difficultics connected with the regulation, in a very sensitive manner, of even continuous current dynamos have not been satisfactorily overcome.

The method usually employed in a series constant current system is that of a shunt being placed across the fields of the dynamo, which is actuated by magnetism in a coil or solenoid through which the main current passes, which actuation increases or decreases the resistance of the shunt according as the current falls too low or rises too high. Or in the case of a shunt-wound dynamo, with which a

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constant E.M.F. is desired, the coil, which is one wound with fine wire and of high resistance, is put right across the poles of the dynamo, and the resistance, which before was used as a shunt across the fields of the dynamos, is now put in series with them, so increasing or decreasing their resistance according as the current rises too high or falls too low.

But in both these cases the sensibility of the regulator must depend upon the mechanical perfection of design, so making an instrument sensitive enough to correct an error of 1 per cent. an exceedingly difficult one to manufacture, and which, when obtained, would be quite impracticable for everyday use. If the difficulties of regulating continuous currents are great, much more so are those of regulating alternating currents, with which the use of magnetism is practically not available; so leaving the thermal effects of the current alone available, as a means of keeping a constant E.M.F. across, or a constant current through, the terminals of the dynamo.

The method adopted in the Lowrie-Hall system for utilising these thermal effects is the use of a wire, rigidly attached at its extremities, and weighted at the centre; then the sag formed in the wire by the central weight, when the wire is expanded by the heat generated by the passage of the current, gives a very efficient and sensitive motion.

Fig. 1 is a diagram which shows very clearly the great advantage of using the sag system. Let A A be the wire rigidly connected at its extremities, A A, whose centre is *c*. Suppose the increase of this wire by expansion to be a length equal to *c b*. Then the half of the wire,

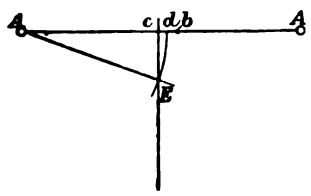

FIG. 1.

A *c*, will increase to A *d*, where *c d* = *d b*. From the centre, A, describe the arc, E *d*, cutting at E the line, *c* E, drawn from the point *c*, which is perpendicular to the normal position of the wire when cold. Then the point E is that to which the centre *c* would fall if the expansion is *b c*. Join A E. Then since in a right-angled triangle the square of the hypotenuse is equal to the sum of the squares of the other two sides,

$$\therefore (A\,E)^2 = (A\,c)^2 + (c\,E)^2.$$

$$\therefore (c\,E)^2 = (A\,E)^2 - A\,c)^2.$$

$$\therefore c\,E = \sqrt{(A\,E)^2 - (A\,c)^2}.$$

Take, as an example, the wire to be 60in. long and its expansion to be one-fourth of an inch, then the sag of the wire

$$= \sqrt{(30 + \cdot125)^2 - (30)^2}.$$

$$= \sqrt{907{\cdot}5 - 900} = \sqrt{7{\cdot}5}.$$

$$= 2{\cdot}74,$$

thus giving a motion of 2·74in. for an expansion of ·25in., or equivalent to a gear multiplying eleven times, with none of the friction or other cause of loss of sensibility appertaining thereto.

Fig. 2 illustrates the practical method of utilising this system of regulation. It is a diagram of the connections as used with an alternating current system, in which it is necessary to keep the E.M.F. across the terminal of the dynamo constant. Across the terminals of the converter, M, two fine wires, E and F, supported between the fixed points, Z Y and Z¹ Y¹, whose normal positions when cold are shown by the dotted lines, are connected; the two wires being in series with one another, and connected by the wire, Y Y¹. The field-magnets of the dynamo, A, are excited by the exciter, B. Across the fields of this exciter a shunt of varying resistance is placed, connected by the wires, *d d*¹; this shunt resistance is formed by two metal plates dipping in the solution in the electrolytic cell, D, and its resistance is altered by the raising and lowering of the plates into the solution, which is accomplished automatically by the passage of a current through either the top coil, C, which lowers them, or the bottom coil, C¹, which raises them, by their attraction for a movable iron core inside the coils. This core is attached to the plates by a cord passing over a pulley, d^2. To the centre of the wire, E, a cord is attached, the other end of which is fixed to the arm, *e*, of the rocking-arm, *e e*¹; this arm is pivoted at e^2 on a fixed support. If, now, the E.M.F. of the

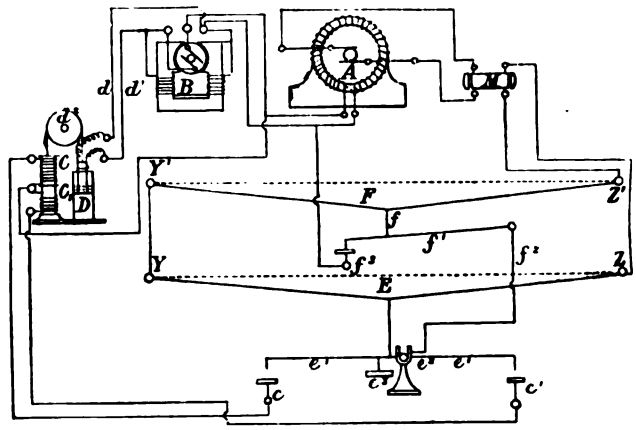

FIG. 2.

dynamo rises too high, the sag becomes greater, and the arm, *e*, is pulled down by the weight, e^3, and so makes contact on the table, *c*; if, however, the E.M.F. falls, the wire pulls the arm, *e*, up, so causing the other arm, e^1, to make contact with the table, c^1. To the centre of the wire, F, the cord, *f*, is attached, which raises or lowers the arm, f^1, pivoted at its end off on to the table, f^3. This table, f^3, is connected to one pole of the exciter, and the pivot of the arm, f^1, is connected by the wire, f^2, to the pivot of the rocking arm, e^2; the table *c* is connected to the top coil, C, and the table c^1 to the bottom coil, C¹, the other ends of these two coils being jointly connected to the other pole of the exciter. If now the E.M.F. of the dynamo rises too high, the arm, *e*, falls, so making contact with the table *c*. The E.M.F. of the exciter is therefore right across the coil C, one side being in metallic connection and the other being connected through the table, f^3, up the arm, f^1, through the wire, f^2, to the arm, *e*, so passing through the table *c* connected with the coil C. This coil coming into action pulls the core up, and so lowers the plates into the solution, which therefore lowers the resistance of the shunt, so causing less current to pass round the fields of the exciter, and consequently weakening the field of the dynamo, A, so lowering its E.M.F. These coils, it should be mentioned, are wound with fine wire and are of high resistance, so their connection across the exciter has no effect upon the dynamo, A. If, however, the E.M.F. is too low, the arm e^1 touches the table c^1 so shunting the current through the coil c^1, which, coming into action, raises the plates out of the solution, and consequently the resistance of the shunt, so that more current passes from the exciter round the fields of the dynamo, A, whose E.M.F. therefore rises. The arm f^1 is put in, to cut out the action of the regulator, in the event of the

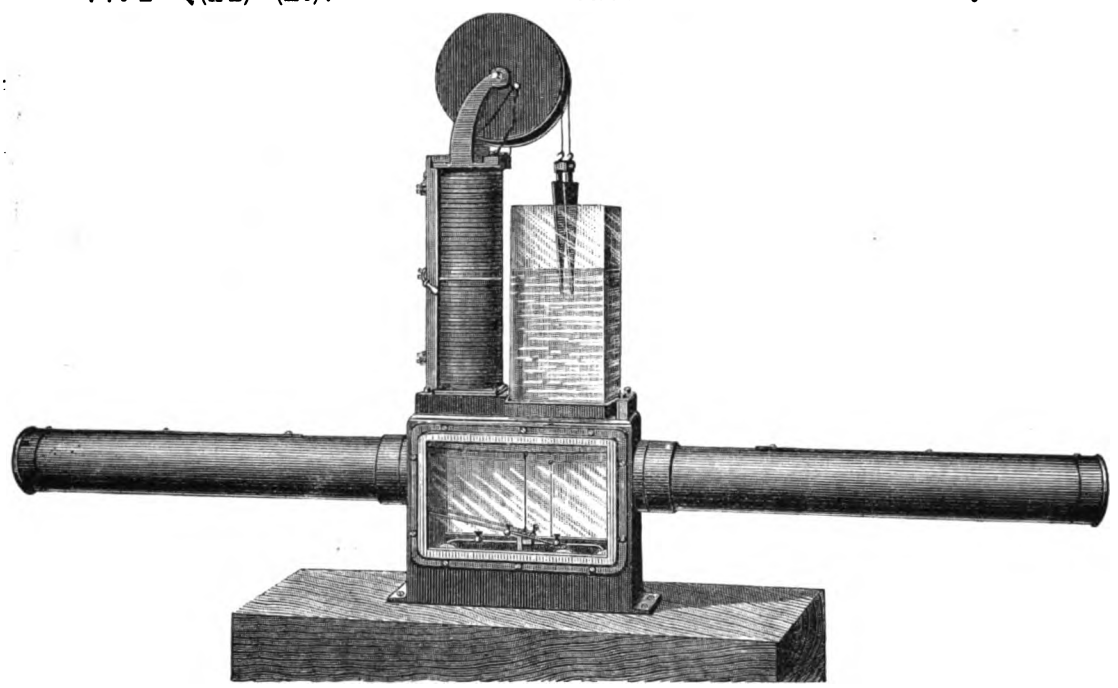

FIG. 3.—Perspective of Apparatus.

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wire E breaking, for that wire, by breaking, would stop the passage of the current through the wire F, so making the latter contract and pull up the arm f^1, so breaking its connection with the table f^3. If no provision is made for this accident, the arm e, by making permanent contact with the table, c, would lower the E.M.F. of the dynamo as far as the shunt would allow. In the event of using this system for the regulation of an alternating current driven direct from the dynamo, the only alteration in the connections is that instead of connecting the wires, E and F, to converter, they would be converted to the dynamo. Fig. 3 is a complete regulator comprising the shunt resistance and the sagging wire arrangement Figs. 4 and 5 show the electrolytic cell arrangement in front and side elevation. In the shunt resistance the two plates which are fixed to an insulating piece dip into the solution contained in the glass cell. The plates are supported by two chains, which pass over the two ebonite wheels. These chains make connection with the plates, and terminate at two terminals, having sufficient slack to allow the wheels to turn their maxim distance either way. On a smaller pulley a chain is fixed, supporting the iron core, which moves up or down in the coils. The speed of the motion of the plates is increased or decreased by the ratio of the diameters of the pulleys. The coils are wound upon a brass tube, which is filled with glycerine, to act as a dash-pot, the core acting as a plunger itself. The plates in the shunt resistance cell should be charged periodically, to reverse the chemical action of the current upon them.

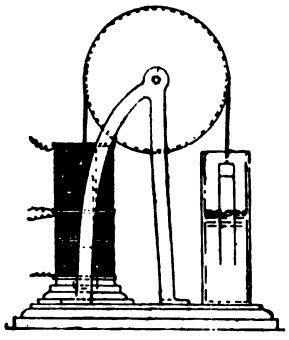

FIG. 4.

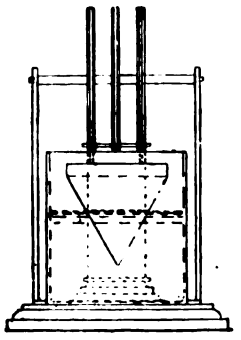

FIG. 5.

In the instrument designed to utilise the sag of the wire, the wires are stretched in a brass tube, in the centre of which is a containing-box. At each end of the tube is a disc or insulation, on one of which are two movable brass strips to tighten the wires by the action of the thumbscrews. These are used to adjust the instrument. On each of these strips is a terminal, so that they make electrical connection to the wires. At the other end of the tube a brass piece is fixed, on to which both wires are screwed. The rocking-arm is jewelled in both movements. The use of the guiding arm is to bring the centre pin on to the bridge, so that when the current ceases the wire is free to contract. All the contacts are made of platinum, and the connections to the tables are made in the terminals underneath. These tables are all adjustable from below, so that their height may be altered without allowing cold air to get in whilst the current is on. The use of the other arm as a cut-out has already been described.

To regulate a continuous-current, series-wound dynamo working on a series system of arc or incandescent lamps, the current, after leaving the dynamo, and passing through the entire circuit, passes through the coils, which are precisely similar ones, in the number of turns, and which actuate a sucking core whose movements raise or lower the plates in the electrolytic cell, which is connected as a shunt across the field-magnet coils of the dynamo. It then passes through a resistance coil and returns to the negative pole of the dynamo. The saging wires are connected together in series, and placed as a shunt across the resistance, so that a portion of the current sufficient to cause the necessary dip from expansion due to the thermal effects passes through them. The use of one wire is that of a cut-out as before described. The action of the arms is to short-circuit one coil, so bringing the other into action, and consequently varying the resistance of the shunt.

It will be seen that in both these cases another method of rendering the instrument still more sensitive, or the reverse, is by moving the attachment of the cord on the rocking arm nearer to or farther from the pivot.

REPORT OF THE ELECTROLYSIS COMMITTEE TO THE BRITISH ASSOCIATION.

During the past year work has been done by the committee as follows:

Prof. Fitzgerald and Mr. Turston have continued their investigation into the accuracy of Ohm's law in electrolytes. Dr. Gladstone and Mr. Hibbert have experimented on the mode of conduction of alloys and solid sulphides. Dr. Armstrong has been preparing some pure selenium with the object of examining its conductivity, and Mr. Crompton, in his laboratory, is engaged in determining the resistance of sulphuric acid of various strengths at different temperatures. Mr. Shaw is continuing the drawing up of his report on recent progress in the whole subject. Dr. Arrhenius has transmitted to the secretaries various reprints bearing on the dissociation hypothesis of electrolytic conduction. Dr. Richardson has also sent some papers. The work of Prof. Rowland and Mr. Bell on the effect of a magnetic field on chemical action, communicated verbally to the section last year, has now appeared in a recent number of the *Philosophical Magazine*.

The most remarkable result to be recorded in the year within the scope of the committee is that obtained by Dr. Hertz, subsequently confirmed by Wiedemann and Ebel Hallwachs and Arrhenius, on the effect of ultra-violet light in making air conducting, and especially in breaking down the transition resistance or obstruction film at the cathode of an electric sparking arrangement. The fact that ultra-violet light is that which most nearly corresponds to the periods of electric oscillation in atoms suggests some chemical or dissociation causes of the effect.

PRACTICAL STANDARDS FOR USE IN ELECTRICAL MEASUREMENTS.

Report of the Committee, consisting of Prof. G. Carey Foster, Sir William Thomson, Prof. Ayrton, Prof. J. Perry, Prof. W. G. Adams, Lord Rayleigh, Dr. O. J. Lodge, Dr. John Hopkinson, Dr. A. Muirhead, Mr. W. H. Preece, Mr. Herbert Taylor, Prof. Everett, Prof. Schuster, Dr. J. A. Fleming, Prof. G. F. Fitzgerald, Mr. R. T. Glazebrooke (secretary), Prof. Chrystal, Mr. H. Tomlinson, Prof. B. Garnett, Prof. J. J. Thomson, Mr. W. N. Shaw, Mr. T. J. Bottomley and Mr. T. Gray, appointed for the purpose of constructing and issuing Practical Standards for Use in Electrical Measurements, to the British Association.

The committee report that the work of testing resistance coils has been continued at the Cavendish Laboratory, and a table of the values found for the various coils is given:

LEGAL OHMS.

No. of coil.	Resistance in legal ohms.	Temperature.
Elliott 193 C.C.L. 178	·99971	15°·5
Elliott 201 C.C.L. 181	1·00005	14°·8

B.A. UNITS.

No. of coil.	Resistance in B.A.U.	Temperature.
Elliott 200 C.C.L. No. 71 ...	1·00049	13°·8
Elliott 43 C.C.L. No. 72 ...	·99955	14°·7

In conformity with the opinion expressed by the committee in their last report some steps have been taken towards the construction of an air condenser. A meeting was held in London, and Dr. Alex. Muirhead exhibited an air condenser, capacity about ·0035 mf. This condenser consists of a series of concentric cylinders of brass, insulated from each other by glass rods.

Dr. Muirhead expressed his willingness to send this condenser to the committee with two others of similar construction, and it was agreed that the secretary should be requested to test them, and to make a determination of their absolute capacity. Some delay in sending the instruments to Cambridge unavoidably took place, but the experiments necessary are now in progress; so far, of the £80 granted last year for the purpose, only £2 10s. has been expended.

During the year the original resistance standards of the association have been compared with each other by the secretary and Mr. T. C. Fitzpatrick; an account of the experiments is given in an appendix to the report, together with a chart giving the values of their resistance between 10° and 20°. The general result of the comparison is that with perhaps one exception the relative values of the standards between the temperatures of 10° and 20° have not changed since they were constructed in 1865 until June, 1888.

The attention of the committee has been directed by several practical electricians to the desirability of re-determination of the value of the specific resistance of copper. It is known that copper wire is now made having a resistance 3 or 4 per cent. less than Matthieson's standard. In view of the importance of copper to electricians, the committee have undertaken to make experiments on the specific resistance of copper, and wish to thank the various gentlemen who have brought the matter forward for their offers of help.

At the last meeting of the committee it was resolved, on the motion of Mr. W. H. Preece, to adopt the name "Therm" for the Gramme water degree centigrade unit of heat.

Thus one "Therm" is the quality of heat required to raise one gramme of water at its maximum density one degree centigrade.

It was also agreed to adopt the name "Joule" for 10^7 C.G.S. units of work. Thus a joule is equal to 10^7 ergs.

It is the work done in one second by the power of one watt, or, again, the work done when a current of one ampere flows for one second between two points, between which the difference of potential is one volt, and hence a power of one watt is one joule per second. Hence, also, if we take the value of the mechanical equivalent of heat as 42×10^7 ergs, we have one therm is equivalent to 4·2 joules.

In accordance with a suggestion made at the Manchester meeting, the value of the resistance of mercury in terms of the B.A. unit has been again determined by the secretary and Mr. Fitzpatrick. They find that a column of mercury 1 metre long, 1 square mm. in section has at 0° C. a resistance of ·95352 B.A. unit, and that the value of the ohm in centimetres of mercury is 106·29.

The committee are of opinion that they should be reappointed with the addition of the name of Mr. T. C. Fitzpatrick to continue the experiments already referred to, and with a grant of £100. They propose that Prof. G. Carey Foster should be the chairman, and Mr. R. T. Glazebrooke, the secretary.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

POWER STATIONS.

The few who have devoted any thought to the subject have undoubtedly formed a very high opinion as to the enormous development that awaits electrical engineering in the way of distributing power. We are convinced that far too little attention has been paid to the subject, and that the glamour of electric lighting has prevented action in a direction that seems to be far less hazardous or risky so far as return for expenditure is concerned. No doubt the subject of electric traction has received a fair amount of attention, and in discussions at societies' meetings the importance of "levelling output" has been shown. But, as a matter of fact, it becomes questionable whether electric lighting will not rather be a bye product, than the primary object of central stations. At present the idea of the work of central stations is to primarily supply light; in many instances, perhaps in the great majority, the primary object should be to supply power. Putting aside the question of what is best for residential districts, let us deal more especially with what concerns business centres. Here almost every house, indeed almost every room, employs power in some shape or form. Steam engines and gas engines are used by the hundred. Among the former it would be exceptional to find one that required less than six pounds of coal per indicated horse power. There is no attempt at economy. The engines used are mostly antiquated patched-up affairs, that, like Paddy's gun, have—lock, stock and barrel—been renewed a dozen times. The stoking is about as wasteful as it can be, and this, added to the uneconomical type of engine, fully reported in black and white, would turn the hair of the modern engineer grey and send him into the asylum, if spoken of as the outcome of engineering practice. We do not know that a single electrical engineer has thought fit to prosecute enquiries into the highways and byeways of the multitudinous industries requiring power carried on in large towns. Perhaps it will surprise them to learn that at a moderate estimate each single horse-power per year costs many a user not less than £30 to £40, yet there are numbers of purveyors of such power who will contract for the same at £10 a year. Other questions besides cost, however, have to be considered. Steam and gas engines take up a large amount of space that is often valuable, dust and dirt are favoured, the heat and smell of oil are sometimes almost intolerable. In the vast majority of cases the motive power required does not exceed six horse-power, varying from a gas engine of one man power. Any of these engines could be replaced by an electric motor, which we contend would be better in all ways. In the first place it would be cheaper, both initially and in maintenance. It is cleaner, requires less attention, can be put into much less space, adds nothing to the cost when

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standing idle, for there is no fire to be kept going, nor water steaming to waste. A switch turned on starts the machine when required, and turned off stops both machine and expenditure. It would be easy to extend the list of advantages, but none of our readers are so ignorant but that they can formulate a list for themselves, quite as well, or better, than we can. We again venture to affirm that, after consideration, there cannot be two conclusions in this matter. One factor in the discussion must never be forgotten, and that is the supply of power appeals more directly to the money-making instincts of the community. "More light" does not appeal so directly to their pockets as cheap and simply-managed power. Electric light is introduced as a luxury, and percolates downwards—power appeals to business men as a commodity for profitable daily use. Manufacturers of steam engines of the better class would gain rather than lose by the introduction of electric motors, while manufacturers of dynamos and motors would largely increase their business. Again, it is not in the interest of manufacturers that large companies are promoted and floated. Limited liability of the ordinary kind will meet with many difficulties in any attempt to open out this idea. The user, duly advised, wants it; the manufacturer naturally urges it; yet, so far, no step has been taken. Why not try the best firm of limited liability, yclept co-operation? In a score of large towns there would be little difficulty in finding centres immediately around which one or two thousand horse-power was required. Shares should be limited in number or amount. The number could be made proportionate to the horse-power required. A man requiring one horse-power usually, and sometimes two, would now probably have a 2½ h.p. vertical engine, costing from £50 to £80. The initial cost of his 2 h.p. motor, and his 2 h.p. share in a big engine of 500 or 1,000 h.p., together with wiring, would not cost more, even if it did not cost less. As we have previously intimated, there is no comparison between the economical working of a 2½ h.p. ramshackle engine, and 2½ h.p in an engine of 500 or 1,000 h.p. nominal. But the great feature of the co-operative scheme is that the user would get everything at cost price. There are no directors, managers, or secretaries of the ordinary type, chosen by promoters, qualified for their positions with gratuitous shares, given by vendors and promoters, no shareholders clamourous for dividends, no pickings here and there by directors kept in office by the manipulation of trust companies. The co-operative scheme is the most honest, most straightforward, and most simple that was ever devised. By its means the users get their apparatus at the normal rates, get the power distributed at cost price, in fact, get it at a cheaper rate than it could be obtained by individual instead of collective action. The great object of business men is to save in expenditure, and if the obtaining power elsewhere than from their own engine involves contribution towards company expenses and shareholders' profits, the trouble to obtain clients to take power will be very great; but if, as in the system suggested, such payments are not contemplated, they will be ready to consider the advisability of joining any scheme of the kind.

A BASIS FROM WHICH TO CALCULATE CHARGES FOR ELECTRIC MOTOR SERVICE.*

BY H. L. LUFKIN.

The theoretical side of the electric motor question has been very ably presented to and discussed by this association, but thus far the practical side has been somewhat neglected.

It will be my purpose in this paper, if possible, to show that there is a general average controlling the use of machinery which it will be safe for electric light and power companies to follow in making their charges for motor service, rather than adopt an arbitrary price per horse-power regardless of the character of service required of the motor.

I have arranged what might be called a power curve,† representing the approximate average actual service in electric motors in connection with the several classes of work represented in the list accompanying the diagram.

	Per Cent.
Exhaust fans	75 to 100
Blowers and blasts	75 to 100
Ceiling fans	75 to 100
Fan outfits	75 to 100
Open-tank elevators	50 to 80
Pressure-tank elevators	35 to 75
Sewing-machine large motors	45 to 60
Sewing-machine small motors	10 to 30
Picture-frame manufacturers	25 to 75
Moulding manufacturers	25 to 75
Platers and buffers	20 to 60
Printing press (news)	30 to 50
Printing press (job)	40 to 80
Machine-shop lathe work	50 to 70
Machine-shop bench work	40 to 60
Laundry machinery	50 to 75
Model and pattern maker	25 to 50
Belt elevators	20 to 60
Coffee mills	40 to 60
Jewellers	25 to 60
Ice cream freezers	25 to 50
Dentists	10 to 20
Opticians	20 to 30
Church organs	10 to 20

This curve is calulated on motors which are only of sufficient capacity in each case to carry the full load. If the motor should be larger than is necessary to drive the machinery, the percentage of actual service will, of course, drop below that shown in the diagram.

By adopting a basis of averages which shall be general among members of this association, the charges for a constant horse-power of current may vary with the circumstances of its first cost in each case, but the general classification of motor service may be a comparatively fixed rule. I am not prepared to say that this is the best plan to follow, but respectfully submit the following as a possible solution of the frequently-asked question, "How shall we charge for electric motor service?"

Exhaust Fans.

First on the list of power consumers is the exhaust fan, taking it in average use. There are, however, circumstances under which its use will be limited to as low as 70 or 75 per cent. of its contract hours of service. As, for instance, in a dining-room it may be cut out except during meal hours, or entirely cut out on cool days. In places of this description, however, its contract use is usually limited

* Paper read before the National Electric Light Association, New York.

† We have given this in tabular rather than graphic form.—Ed. *E. E.*

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to three or four months in the year, and other than electric power is, by circumstances of first cost and inconvenience, but a feeble competitor. The first four applications on the accompanying list—viz., exhaust fans, blowers, ceiling fans, and fan outfits, are all more or less subject to the foregoing conditions; and, therefore, current supplied to motors for these purposes commands the maximum price per horse-power. One important feature in the installation of ceiling fans is the counter-shafting to the motor. In one recent case we had a complaint from a customer that the ½ h.p. motor sent him would not drive two ceiling fans, and that the motor must be defective, and should be returned for repairs. We immediately sent a representative to find the difficulty, which was found, as is usual in such cases, in the counter-shafting, or, rather, the want of it. The 3in. pulley on the motor was connected to a 6in. pulley on the line shafting. The rated speed of the motor was 2,000 revolutions, and had it been able to develop this speed, would have driven the line shaft 1,000 revolutions, and the fans at a relative speed. To accomplish this would probably require a motor of 3 h.p. or 4 h.p. The line-shafting driving ceiling fans usually runs about 75 revolutions. To give this speed on the line shaft with a rated speed of 2,000 on the 3in. pulley of the motor would require a counter-shaft with a 24in. pulley belted to the motor. On this same counter-shaft should be a 5in. pulley belted to a 15in. or 16in. pulley on the line shaft. Fully three-fourths of the trouble found in electric motors arises from improper shafting and belting. A ½ h.p. motor should drive the average make of 30in. exhaust wheel, about 400 revolutions. Say, then, the speed of the motor is 2,000 and the pulley 3in., it would require a 15in. pulley on the fan to do the work; a 36in. wheel requires 1 h.p. to develop the same speed. If the motor speed is 1,800, the pulley 4in., it would require an 18in. pulley on the fan to do the work. These are the most popular sizes of exhaust wheels.

The next application on the list, open tank elevator pumps, commands the highest price for current per h.p. in the motor of any elevator application. The methods of operating the open tank hydraulic elevators in question are undoubtedly familiar to you all. Instead of the usual steam-pump a power-pump of some approved design is substituted and connected to the motor by suitable counter-shafting to give the required revolutions at the pump. The regulation of the motor in this case should be controlled by the position of water in the lower tank, as in the case of the steam-pump. And in this connection let me suggest the necessity of great care both in installation and insulation. On all installations in basements and cellars or elsewhere, where there is the slightest tendency to dampness, raise the motor off the floor on a suitable frame or stand, and build around it on all sides of possible approach a low platform, using glass insulators as legs or standards to support it. So arrange this that the motor or its connections cannot be reached except when standing on this insulated platform, and the liability to a shock will be reduced to the difference of potential between the terminals of the machine. To return to the subject. Let us take for an illustration an insulator using 120 gallons of water per trip, and consuming one minute in making its entire up trip, or about two per round trip. The lower tank or water supply is on a level with the pump. The upper tank is 70ft. above the pump, and in the piping to the upper tank are five elbows. For each elbow add 2ft. to the elevation, or an approximate total elevation of 80ft. × 120 gallons, gives us 9,600 foot gallons. This amount would be required every two minutes if the elevator was in absolutely constant operation, or 4,800 foot gallons per minute × 8½ gives us 4,800 foot pounds. This we must at least double to allow for friction in pump, shafting, &c., making 81,600 foot pounds, or about 2½, say 3 h.p., required in the motor.

This class of elevator is confined almost entirely to passenger use; therefore, the service required of the motor is much more constant, and the margin between the horse-power hours contracted for, and the horse-power hours of actual service much smaller than in any other elevator use, excepting, possibly, the service in connection with pressure tank elevators in the more popular office buildings. In this case we have a maximum average use of 80 per cent., and instances such as the hotels, small office buildings, &c., where the service will not exceed 60 per cent. of the contract horse-power hours. In order, however, that the electric light company shall derive the greatest benefit from this inconstant service, the installation and wiring should be the best, and only the most approved and economical apparatus employed.

The next application on our list, pressure tank pumps in connection with elevators, represents a somewhat smaller percentage of horse-power hours of actual service in the motor, as compared with the possible horse-power hours, than in the case of an open tank pump. In case of the pressure tank the water reserve is usually limited, and the motor, therefore, must be equal to the continuous operation of the elevator at maximum load. Taking this fact into consideration, and the circumstances of elevator use being about the same in this case as in case of the open tank elevator, we have a greater ratio of difference between the possible or contract horse-power hours in the motor, and the horse-power hours of actual service, the maximum average use being about 70 to 75 per cent., and the minimum as low as 35 to 40 per cent., depending, of course, on the character of building in which the elevator is employed or the character of service. In calculating the size of motor required on an elevator of this description a very convenient fact to remember is, that every pound of pressure per square inch is equivalent to lifting water about 23ft., or about 230ft. per 100 pounds pressure. By reducing the required pressure to a relative lift in feet, and knowing the amount of water required by the elevator per minute, the motor calculation becomes the same as in case of the open tank elevator, the same allowances being made for friction, &c., as in the first case. The regulation of the motor in this case should be accomplished by the conditions of pressure in the pressure tank, as is the case with a steam pump employed in this service.

The next application of importance on the list is sewing-machines. In the tests I have been able to make on this class of work I have obtained some singular results. One item of importance is the fact that the single thread machines, which are lightest running, consume the most power in operating. Paradoxical as this may seem, it is easily explained. As a rule this class of machine is used on light work such as shirts, ladies' underwear, &c., and operated at a higher speed than any other class of machine. At equal speed the volts consumed on a single thread machine, as compared with a shuttle machine, are about as two to three. In average commercial use, however, the positions are reversed, and the ratio of volts consumed in the single thread, as compared with the shuttle machine, is about as five to three. To double the speed on a sewing machine requires about two and a half times the power. The difference in volts consumed on the different makes of sewing-machines is so small that we may disregard it entirely, as well as the character of work done by the machine, for the heavier the work the slower the speed, and more frequent and longer stops on the machine, thus keeping the average volts per operator about constant in all cases. This leaves the speed in stitches per minute at the sewing-machine the factor from which we must calculate the power required in a sewing-machine plant. To illustrate this I will give you the record of two cases, which are about the average. Case No. 1. is a shop in which are 30 sewing-machines, connected to a 2 h.p. motor. At the time the tests were made there were but 20 operators at work, leaving 10 idle machines, the entire shafting, however, being in operation. The class of goods manufactured in this shop is a cheap grade of cotton and wool trousers, rather heavy goods to sew. A voltmeter across the terminals of the motor gave the following readings, with the current at 9 amperes. Minimum, 90 volts; maximum, 148 volts; average, 119; which gives us a minimum average per operator of 4·5 volts, and a maximum average of 7·4 volts, or a general average of 5·9 volts per operator. This motor was driving the shafting for 30 machines, and as the average operators employed the year round will not exceed 75 per cent. of the shop capacity, it will, I think, be entirely fair to estimate the average volts per machine rather than per operator, as the user of the motor has contracted for power sufficient to drive his entire plant. In this case, then,

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we have a minimum average of 3 volts per machine, and a maximum of 4·9 volts, or a general average of, say, 4 volts per machine. A 2 h.p. motor of 82 per cent. efficiency, with 9 amperes of current, will require about 200 volts to develop two actual h.p. Two hundred volts, therefore, is what the electric light company contracts to deliver, while in reality they deliver only 129 volts, or 60 per cent., or a minimum average of 90 volts, or 45 per cent. of the power contracted for. These machines were making about 1,200 stitches per minute, an average of 4 volts per 100 stitches.

Case No. 2 is a shop in which there are thirty-two machines, running at about 1,200 stitches, each being supplied with an individual motor of ⅛ h.p. capacity, and the class of goods manufactured being men's summer clothing, such as white duck vests, flannel coats, and vests, &c., the duck from which these vests are made being about as hard work on a sewing-machine as can be found. In this shop were twenty-four operators at work. The maximum volts in this case were 116, and the minimum 40, a general average of but 78 volts, or about 2½ volts per machine, with four more operators than in the first case, in which we had an average of 119 volts. This shop has been paying the electric light company 32dols. (133s.) per month for more than a year, which is the price the same company charge for current for a 4 h.p. motor, approximately 400 volts, which the company contracts to deliver. This gives us a minimum average use of but 10 per cent., and a maximum of 29 per cent., with a general average of 19½ per cent. In other words, the company is saving in this shop the price of a ⅛ h.p. motor each month, besides making a profit on the volts actually delivered. On a contract for three years the electric light company would be money in pocket if they would present the customer with 30 small motors, charging him 1dol. (4s. 2d.) per month per motor for current rather than let him buy a 2 h.p. motor to operate the same machines with the necessary shafting at a charge of 18dols. (75s.) per month for current. Taking this average, in case No. 2, of 2½ volts per machine, from a 50-light machine we could run not less than 900 sewing-machines, or about 18 to the arc lamp. At 1dol. (4s. 2d.) per month per machine an income of 900dols. (£187. 10s.) per month would be derived from a 50-light machine without any lamp expenses such as carbons, repairs on lamps, globes, &c. On the average, in case No. 1, of 4 volts per machine, we could operate but about 562, say 600, machines. Divided up in shops of thirty machines, and a 2 h.p. motor to each shop, we would have twenty 2 h.p. motors. At a charge of 18dols. (75s.) per month each we would have an earning capacity of but 360dols. (£75) per month from the same 50-light machine.

This is but one page from the thus far unwritten history of the much maligned small motor. Still the question is frequently asked, "Can we sell current for 1dol. (4s. 2d.) per per month for a small motor driving a sewing-machine and make a profit?" As a matter of fact, 50c. (2s. 1d.) per month for small motors driving sewing-machines yields a better profit to the company supplying the current than 10dols. (41s. 8d.) per month per horse-power in large motors to drive the same machines; besides the immense advantage which the small motors possess of keeping the circuit in much better balance, the fluctuations due to the stopping and starting of large motors being at times a serious matter. One electric light company, making rather a specialty of these small machines, rent the motor and supply the current for 1dol. 25c. (5s. 2½d.) per month per sewing-machine, and report that at this price the motor service pays them a better percentage of profit than their lamps. This company have some 200 small motors on their circuits.

A more striking illustration of the advantages to the electric light company in the sub-division of power into the smallest possible units it would be hard to find. There is a difference in efficiency of from 15 to 20 per cent. in these two sizes of motors; but this difference is fully lost to the large motor in driving the shafting, and the small motor still has the advantage of being out of circuit entirely when the machine it is driving is stopped. There is scarcely a manufacturing industry which does not possess its busy and dull seasons. This means that in no industry will over 75 per cent. of the machines or machinery employed be in average operation. The shafting in these shops must be kept in operation the entire year, often for less than 50 per cent. of the machinery. Sub-divide these same shops into as many small units as possible, and the current necessary to operate the shafting for this idle machinery will be saved, besides the saving from frequent stops while the machinery is in active use.

To return again to the list, the next two applications, picture frame manufacturers and moulding manufacturers, are very similar. Their busy seasons, as a rule, are in the spring and fall, and also follow closely any activity in house building. In the case of the larger manufacturers in this line a maximum average of 75 per cent. will possibly be reached but probably never exceeded. In the case, however, of the picture dealer who has a small shop, in which he makes picture frames and mouldings to order, the actual service of the motor will fall as low as 25 or 30 per cent. of its contract hours, one case in our experience the actual service having reached this low average. A fair average in this class of work would be about 60 per cent.

The next application, nickel and silver platers and buffers, are good contract customers as a rule. One case in our experience showing but an average use of 20 per cent. of the contract horse-power hours. This, however, is probably an exceptional case, and as near as we can estimate on this class of work, the actual motor service will not exceed, in any case, 60 per cent. of the contract hours; a fair average being probably 45 or 50 per cent.

The next two applications, printing presses on news and job work, are probably met with more frequently than any other. On exclusively news work the instances where the motor is in service more than three or four hours is rare. It is, however, usual in news offices to find two or more job presses. If the newspaper printed happens to be a morning paper, the hours of news work are usually between twelve midnight and four o'clock in the morning, the job work being done during the day. I have in mind a case of this description. In the shop is one cylinder press and three job presses connected to a 2 h.p. motor. This motor is on an incandescent circuit of 110 volts. To develop its rated power at 110 volts would require about 16 amperes in the motor. An ampere meter in series with the motor, while running off the morning paper, with only the cylinder press in operation, stood at 12 amperes. For three hours this load was practically constant, when it was thrown off entirely. This gave on the night service but 30 per cent. of the contract hours. This motor required 5 amperes to drive the shafting, and but 8 amperes, or 1 h.p., to drive the three job presses with the cylinder press off. Here, then, is but a 50 per cent. use if the presses be used constantly. There are, however, many days when they are comparatively idle; 30 to 40 per cent., therefore, is a very safe estimate of the maximum use of this motor on the day circuit, or had the motor been a 1 h.p., which would have been sufficient to drive the job presses, the use would be 60 to 80 per cent. of the contract hours, probably not above 60 per cent. All printing offices will probably come within this range, unless the motor be larger than is necessary to the work.

Machine shops, doing principally lathe work, as a matter of course use a larger percentage of their contracted power than shops doing lathe and bench work with the same hands. In no case will the service of the motor exceed 65 or 70 per cent. of its contract use, for machine shops, like sewing-machine shops, will never average over 75 per cent. of the shop capacity for operators the year round. The average, especially in the case of a shop doing much bench work, will fall as low as 40 per cent.

The driving of laundry machinery, which is our next application, usually proves a profitable contract, according to reports. This fact arises from the intermittent use of the machinery. The heaviest service on the motor will probably be found during the early part of each week, with a general falling off in work during the summer months, while the patrons of the laundry are away at the seashore or in the mountains. In this application, therefore, a 75 per cent. service would probably be an exception, and probably many instances where the service would fall below 50 per cent.

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The next application, model and pattern makers, are small users of power, as their occupation requires a large proportion of hand work. Fifty per cent. service in the motor will be found a fair average maximum use, with instances as low as 20 or 25 per cent.

The next application, direct power or belt elevators, is another application frequently met. The average service in the motor is also much smaller than in any other elevator application. Let us suppose a case of the familiar grip connected to the ordinary hand-hoist, with a lifting capacity of 2,000 pounds. In this case the motor is in use only going up, and the usual break is used in coming down. Connected to this elevator, in the loft of the building, we have a 5 h.p. motor wired to a cut-out on the ground floor. We will call the lift 45 feet and the time consumed per trip one minute. We will allow sixty full trips of the elevator, at full load of 2,000lb. per trip each day. This would approximate ten car loads of merchandise handled by the elevator, which is certainly above the average. This motor, we will say, is on a ten-hour day circuit, its possible horse-power hours, therefore, would be 5 h.p. for ten hours, or 50 h.p. hours per day. Sixty trips of one minute each gives us exactly one hour's service of the full 5 h.p. or 5 h.p. hours. To drive the shafting only while the elevator is coming down or idle, would require about 150 volts, or 1½ h.p., and if this was in constant operation the balance of the day, nine hours, its total use on shafting would be 13½ h.p. hours, which, added to the 5 h.p. hours, gives us a grand total of 18½ h.p. hours, or 37 per cent. of the contract hours. If, however, the user of the motor avails himself of the cut-out box, and cuts the current out when the motor is not in use, the average use would drop to 20 or 25 per cent. instead of 37 per cent. In the case of a direct power passenger elevator the use might possibly run up to 60 per cent., but this would be exceptional.

Coffee mills will average from 40 to 60 per cent. of their contract hours. Manufacturing jewellers about the same, while retail jewellers will run as low as 25 per cent. Ice cream freezers will not average over 25 per cent.; but as the contract season in this case is usually short, they should be rated at least on a 50 per cent. basis, except, possibly, in cases where the customer pays the cost of installation and wiring, which is usual in these cases.

A dentist is one of the smallest of power users—so small, in fact, that if everyone in a city were connected with a circuit, the load from this cause would never be felt. We will, however, put them down at from 10 to 20 per cent.

The optician uses a motor to turn his grindstones, and its use in this case will average from 20 to 30 per cent.

The last application on the list, church organs, use only from 10 to 20 per cent. of the contract service.

These are, of course, but few of the very many applications of the electric motor; and if, as I trust, the possible subsequent discussion of this general plan may establish a basis for rating motor applications, not only will the objects of this paper be obtained, but a question of considerable annoyance now existing between the motor man and the electric light or power company will be solved.

In conclusion, Mr. Chairman, I beg to suggest that the supply and rates of charge for electric power have become of sufficient importance to this association to be represented by a permanent committee, whose duty it should be to obtain from the different members of this association, as far as possible, their experience in the supply of power, in such manner and form as shall be deemed by the committee best suited to the wants of this association.

Speed of Projectiles.—A telephonic method of measuring the speed of projectiles is proposed. The use of screens, however thin, must be attended with some loss of energy and deflection of the projectile, but a series of telephonic transmitters, actuated by the induction of the moving mass of metal upon an induction balance apparatus, can indicate electrically the passage of the projectile at different points in its flight without interfering in any way with its progress.

A SIMPLE HYPOTHESIS FOR ELECTRO-MAGNETIC INDUCTION OF INCOMPLETE CIRCUITS; WITH CONSEQUENT EQUATIONS OF ELECTRIC MOTION IN FIXED HOMOGENEOUS OR HETEROGENEOUS SOLID MATTER.*

BY SIR WILLIAM THOMSON.

1. To avoid mathematical formulas till needed for calculation, consider three cases of liquid† motion, which for brevity I call Primary, Secondary, Tertiary, defined as follows: Half the velocity in the secondary agrees numerically and directionally with the magnitude and axis of the molecular spin at the corresponding point of the Primary; or (short, but complete, statement) *half the velocity in the Secondary is the spin in the Primary, and (similarly) half the velocity in the Tertiary is the spin in the Secondary.*

2. In the Secondary and Tertiary the motion is essentially without change of density, and in each of them we naturally, therefore, take an incompressible fluid as the substance. The motion in the Primary we arbitrarily restrict by taking its fluid also as incompressible.

3. Helmholtz first solved the problem—Given the spin in any case of liquid motion, to find the motion. His solution consists in finding the potentials of three ideal distributions of gravitational matter having densities respectively equal to $1/4\pi$ of the rectangular components of the given spin; and, regarding for a moment these potentials as rectangular components of velocity in a case of liquid motion, taking the spin in this motion as the velocity in the required motion. Applying this solution to find the velocity in our Secondary from the velocity in our Tertiary, we see that the three velocity-components in our Primary are the potentials of three ideal distributions of gravitational matter having their densities respectively equal to $1/4\pi$ of the three velocity-components of our Tertiary. This proposition is proved in a moment,‡ in § 5 below, by expressing the velocity-components of our Tertiary in terms of those of our Secondary, and those of our Secondary in terms of those of our Primary; and then eliminating the velocity-components of Secondary, so as to have those of Tertiary directly in terms of those of Primary.

4. Consider now, in a fixed solid or solids of no magnetic susceptibility, any case of electric motion in which there is change of electrification, and therefore no incomplete electric circuit, or, which is the same, any case of electric motion in which the distribution of electric current agrees with the distribution of velocity in a case of liquid motion. Let this case, with velocity of liquid numerically equal to 4π times the electric current density be our Tertiary. The velocity in our corresponding Secondary is then the magnetic force of the electric current system;§ and the velocity in our Primary is what Maxwell‖ has well called the "electro-magnetic momentum at any point" of the electric current system; and the rate of decrease per unit of time of any component of this last velocity at any point is the corresponding component of electromotive force, due to electro-magnetic induction of the electric current system when it experiences any change. This electromotive force, combined with the electrostatic force, if there is any, constitutes the whole electromotive force at any point of the system. Hence by Ohm's law each component of electric current at any point is equal to the electric conductivity multiplied into the sum of the corresponding component of electrostatic force and the rate of decrease per unit of time of the corresponding component of velocity of liquid in our Primary.

5. To express all this in symbols, let (u_1, v_1, w_1), (u_2, v_2, w_2), and (u_3, v_3, w_3) denote rectangular components of the velocity at time t, and point (x, y, z) of our Primary, Secondary, and Tertiary. We have (§ 1)—

$$u_2 = \frac{dw_1}{dy} - \frac{dv_1}{dz}, \quad v_2 = \frac{du_1}{dz} - \frac{dw_1}{dx}, \quad w_2 = \frac{dv_1}{dx} - \frac{du_1}{dy}. \quad (1)$$

$$u_3 = \frac{dw_2}{dy} - \frac{dv_2}{dz}, \quad v_3 = \frac{du_2}{dz} - \frac{dw_2}{dx}, \quad w_3 = \frac{dv_2}{dx} - \frac{du_2}{dy}. \quad (2)$$

Eliminating u_2, v_2, w_2 from (2) by (1), we find—

$$u_3 = \frac{d}{dx}\left(\frac{du_1}{dx} + \frac{dv_1}{dy} + \frac{dw_1}{dz}\right) - \left(\frac{d^2u_1}{dx^2} + \frac{d^2u_1}{dy^2} + \frac{d^2u_1}{dz^2}\right); \text{ &c.} \quad . \quad . \quad (3)$$

But by our assumption (§ 2) of incompressibility in the Primary—

$$\frac{du_1}{dx} + \frac{dv_1}{dy} + \frac{dw_1}{dz} = 0 \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Hence (3) becomes—

$$u_3 = -\nabla^2 u_1, \; v_3 = -\nabla^2 v_1, \; w_3 = -\nabla^2 w_1 \quad . \quad . \quad . \quad (5)$$

where, as in Article XXVII. (November, 1846) of my "Collected Papers" (Vol. I.)—

$$\nabla^2 = \frac{d^2}{dx^2} + \frac{dy^2}{d^2} + \frac{d^2}{dz^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6) \text{ ¶}$$

This (5) is the promised proof of § 3.

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* Paper read before the British Association at Bath.

† I use "liquid" for brevity to signify incompressible fluid.

‡ From Poisson's well-known elementary theorem, $\Delta^2 V = -\pi\rho$.

§ "Electrostatics and Magnetism," § 517 (Postscript) (*c*).

‖ "Electricity and Magnetism," §§ 604, 585.

¶ Maxwell, for quarternionic reasons, takes ∇^2 the negative of mine.

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6. Let now u, v, w denote the components of electric current at (x, y, z) in the electric system of § 4; so that—

$$4\pi u = u_2 = -\nabla^2 u_1 ; \; 4\pi v = v_2 = -\nabla^2 v_1 ;$$
$$4\pi w = w_2 = -\nabla^2 w_1 ; \quad . \quad . \quad . \quad . \quad . \quad (7)$$

which, in virtue of (4), give—

$$\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Hence the components of electromotive force due to change of current, being (§ 5)—

$$-\frac{du_2}{dt}, \quad -\frac{dv_2}{dt}, \quad -\frac{dw_2}{dt},$$

are equal to—

$$4\pi\nabla^{-2}\frac{du}{dt}, \quad 4\pi\nabla^{-2}\frac{dv}{dt}, \quad 4\pi\nabla^{-2}\frac{dw}{dt} ; \quad . \quad . \quad (9)$$

and therefore if Ψ denote electrostatic potential, we have, for the equations of the electric motion (§ 5)—

$$u = \frac{1}{\kappa}\left(\nabla^{-2}\frac{du}{dt} - \frac{d\Psi}{dx}\right) ; \quad v = \frac{1}{\kappa}\left(\nabla^{-2}\frac{dv}{dt} - \frac{d\Psi}{dy}\right) ;$$
$$w = \frac{1}{\kappa}\left(\nabla^{-2}\frac{dw}{dt} - \frac{d\Psi}{dz}\right) \quad . \quad . \quad . \quad . \quad (10)$$

where κ denotes $1/4\pi$ of the specific resistance.

7. As Ψ is independent of t, according to § 4, we may conveniently for a moment put—

$$u + \frac{d\Psi}{\kappa dx} = \alpha ; \; v + \frac{d\Psi}{\kappa dy} = \beta ; \; w + \frac{d\Psi}{\kappa dz} = \gamma \quad . \quad (11)$$

and so find as equivalents to (10)—

$$\frac{d\alpha}{dt} = \nabla^2_2(\kappa\alpha) ; \; \frac{d\beta}{dt} = \nabla^2(\kappa\beta) ; \; \frac{d\gamma}{dt} = \nabla_1^2(\kappa\gamma) ; \quad (12)$$

The interpretation of this elimination of Ψ may be illustrated by considering for example a finite portion of *homogeneous* solid conductor of any shape (a long thin wire with two ends, or a short thick wire, or a solid globe, or a lump of any shape, of copper or other metal homogeneous throughout), with a constant flow of electricity maintained through it by electrodes from a voltaic battery or other source of electric energy, and with proper appliances over its whole boundary, so regulated as to keep any given constant potential at every point of the boundary; while currents are caused to circulate through the interior by changing currents in circuits external to it. There being no *changing electrification* by our supposition of § 4, Ψ can have no contribution from electrification within our conductor; and therefore throughout our field—

$$\nabla^2\Psi = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

which, with (8) and (11), gives—

$$\frac{d\alpha}{dx} + \frac{d\beta}{dy} + \frac{d\gamma}{dz} = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

Between (12) and (14) we have four equations for three unknown quantities. These, *in the case of homogeneousness* (κ constant), are equivalent to only three, because in this case (14) follows from (12), provided (14) is satisfied initially and proper surface condition is maintained to prevent any violation of it from supervening. But unless κ is constant throughout our field, the four equations (12) and (14) are mutually inconsistent; from which it follows that our supposition of unchangingness of electrification (§ 4) is not generally true. An interesting and important practical conclusion is that when currents are induced in any way in a solid composed of parts having different electric conductiveness (pieces of copper and lead, for example, fixed together in metallic contact), there must in general be changing electrification over any interface between these parts. This conclusion was not at first obvious to me; but it ought to be so by anyone approaching the subject with mind undisturbed by mathematical formulas.

8. Being thus warned off heterogeneousness until we come to consider changing electrification and incomplete circuits, let us apply (10) to an infinite homogeneous solid. As (8) holds through all space according to our supposition in § 4, and as κ is constant, (13) must now hold through all space, and therefore $\Psi = 0$, which reduces (10) to—

$$u = \frac{1}{\kappa}\nabla^{-2}\frac{du}{dt} \quad v = \frac{1}{\kappa}\nabla^{-2}\frac{dv}{dt} \quad w = \frac{1}{\kappa}\nabla^{-2}\frac{dw}{dt}. \quad (15)$$

These equations express simply the known law of *electro-magnetic* induction as we have it, and all we know about it from direct experiment. Maxwell's equations (7) of § 783 of his "Electricity and Magnetism" become in this case—

$$\mu\left(4\pi C + K\frac{d}{dt}\right)\frac{du}{dt} = \nabla^2 u, \text{ &c.} \quad . \quad (15')$$

which cannot be right, I think (!!!), according to any conceivable hypothesis regarding electric conductivity, whether of metals, or stones, or gums, or resins, or wax, or shellac or guttapercha, or india-rubber, or glasses, or solid or liquid electrolytes; being, as seems (!) to me, vitiated for complete circuits, by the curious and ingenious, but, as it seems to me, not wholly tenable, hypothesis which he introduces, in § 610, for incomplete circuits.

9. The hypothesis which I suggest for incomplete circuits and consequently varying electrification, is simply that the components of the electromotive due to electro-magnetic induction are still $4\pi\nabla^{-2}du/dt$, &c. Thus for the equations of motion we have simply to keep equations (10) unchanged, while not imposing (8), but instead of it taking—

$$\text{"}v\text{"}^2\left(\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz}\right) = \frac{d}{dt}\nabla^2\Psi \quad . \quad . \quad . \quad (16)$$

where "v" denotes the number of electrostatic units in the electromagnetic unit of electric quantity. This equation expresses that the electrification of which Ψ is the potential increases and diminishes in any place according as electricity flows more out than in, or more in than out. We thus have four equations (10) and (16) for our four unknowns, u, v, w, Ψ; and I find simple and natural solutions with nothing vague, or difficult to understand, or to believe when understood, by their application to practical problems, or to conceivable ideal problems; such as the transmission of ordinary or telephonic signals along submarine telegraph conductors and land-lines, electric oscillations in a finite insulated conductor of any form, transference of electricity through an infinite solid, &c. This, however, does not prove my hypothesis. Experiment is required for informing us as to the real electro-magnetic effects of incomplete circuits, and, as Helmholtz has marked, it is not easy to imagine any kind of experiment which could decide between different hypotheses which may occur to anyone trying to evolve out of his inner consciousness a theory of the mutual force and induction between incomplete circuits.

ON THE IMPEDANCE OF CONDUCTORS TO LEYDEN JAR DISCHARGES.*

BY DR. OLIVER LODGE.

Among other experiments which I made in connection with lightning conductors were some on what I call "the alternative path." These gave some surprising results, showing that iron and copper acted equally well as conductors, and that sometimes the iron was better than copper; also that thickness of conductor and ordinary conductivity mattered very little.

Since then I have more completely applied the theories of Clerk-Maxwell and Lord Rayleigh concerning the impedance of conductors to very high frequencies of alternation, and have been able to arrive at a complete understanding of all, or nearly all, the alternative path results. I bring forward these experiments, therefore, as a verification of Lord Rayleigh's modification of Maxwell for extremely high frequencies.

Impedance being defined as

$$\sqrt{R'^2 + p^2 L'^2} \left| \frac{I}{pL'} \right. R'$$

Rayleigh develops an expression of Maxwell's for E.M.F. into expressions for R′ and L′, which take the form, when p is infinitely great,

$$R' = \sqrt{\tfrac{1}{2} p l \mu_0 R}$$
$$L' = L + \frac{R'}{p},$$

these being the limits of a Bessel function series, where L refers only to the medium outside the substance of the wire, and μ_0 is the magnetic permeability of the material of the wire, l being its length.

Wherefore, $$I = \sqrt{(pL' + R')^2 + R'^2}$$
$$= p\,L\sqrt{1 + \frac{2m}{\sqrt{p}} + \frac{2m^2}{p}},$$

where $m = \dfrac{\sqrt{\frac{1}{2} l \mu_0 R}}{L}$.

L depends on the size and shape of the conductor, but not at all on its material, and it only depends slightly on its thickness; m depends on the conducting substance, and increases with both μ and R. R is the ordinary resistance of the wire.

At very high frequencies the first term of those under the root in the expression for I alone matters, and therefore all substances which conduct at all behave in the same way. At less frequencies the terms involving R and μ begin to be of importance.

All this is borne out by the experiments, and the theoretical impedance is found to be very nearly proportional to the observed difference of potential needed to drive a given charge through any given conductor.

The experiment is conducted thus:

Two jars are arranged to be charged and discharged at A. The circuit is completed either by an air gap at B, or by the conductor to be experimented on. The conductor is arranged in the form of a circle, and connects the B knobs so as to afford an alternative path. The experiment consists in adjusting the B knobs until the spark jumps

* Paper read before the British Association at Bath.

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the air jet just about as often as it misses and chooses the conductor, the size of the jars, the length of the A spark, and the position of A on the two wires connected to the inner coatings being the things varied in successive series experiments. A whole lot of circular conductors, I, are tried one after the other with each adjustment.

The length of spark B measures the E.M.F. needed to effect discharge through the conductor.

This is found proportional to the theoretical impedance for

No. 2 Iron,	No. 5 Copper,	No. 2 Brass,
No. 18 Iron,	No. 18 Copper,	No. 24 Brass,
No. 25 Iron,	No. 23 Copper,	
	No. 40 Copper,	

with frequencies varying in different experiments from 12 million vibrations per second to a quarter million vibrations per second.

The current amplitude during the discharge was 3,000 amperes, sometimes more, sometimes less.

The impedance of a conductor 2½ metres long bent into a circle was

180 ohms for thick wire, No. 2 } at 12 millions per
300 ohms ,, thin ,, 40 } second,

the ordinary resistance being ·004 ohms and 2·6 ohms respectively.

43 ohms for thick ..... } at 3 millions.
78 ohms ,, thin ..... }

At a quarter million vibrations the material just begins to become important, and iron has a trace more impedance than copper; but even now they are practically equal, being about 4 ohms for thick and 6 ohms for extremely thin wire.

These are the results of the latest experiments. In some of the older experiments iron came out distinctly better than copper—even thin iron better than thick copper.

Theory does not, so far as I see, throw any light upon this, and I am going to repeat those experiments in something like their original form, so as either to confirm or to modify these few anomalous results.

The main point established is that for frequencies comparable to a million per second, such frequencies as occur in jar discharges and probably in lightning, the impedance of all reasonably-conducting materials is the same, both by theory and by experiment, independently of their magnetic properties as well as of their conductivity; and that even the sectional area of a conductor only affects its impedance in a minor degree, so that a change to $\frac{1}{1000}$ the area scarcely doubles the impedance.

ON THE INTENSITY OF MAGNETISATION OF SOFT IRON BARS OF VARIOUS LENGTHS IN A UNIFORM MAGNETIC FIELD.*

BY A. TANAKADATE.

Experiments were made on bars for which the ratio of length to diameter varied from 13 to 32: the bars were subjected to different strengths of magnetising fields, and the magnetic moments thereby acquired were measured, the mean intensity of magnetisation being then calculated. The results agreed with Prof Ewing's on bars, for which the above ratio varied from 50 to 300.

Mention is made also of some experiments by the author in 1883, wherein a magnetic field of constant strength was used to act on a mass of iron that was varied by steps. The mass consisted of iron wires which were varied in number. With a field of 46 C.G.S. units the magnetometer deflexion was sensibly proportional to the number of wires up to 10; as the number of wires was increased the ratio of deflexion to number diminished, the maximum deflexion practically occurring with 25 wires, no greater deflexion occurring with 41 wires. When the wires numbered more than 10, some of them would be thrown out of the bundle, requiring pressure to keep them in the solenoid, though the whole bundle could with care be so placed that no wire would jump out. Each wire was obviously in an unstable state of equilibrium, being under the action of opposed forces, one from the solenoid tending to throw it out, and the other from its fellow wires tending to eject it.

Discussion.

Prof. Rowland said some time ago he was interested in this question, and calculated various formulæ, and by that means got at the self-induction of a coil with a piece of iron in it. The result was interesting, and showed that the self-induction was not dependent upon the diameter of the iron at all, but only on its length. This was an entirely different result from that given in Maxwell. He had actually tested the self-induction of a coil with iron in it, and had compared it with his formula. It came out exactly as the formula indicated. That seemed to be the same result as that expressed in Faraday's theory, that the magnetisation to which iron can be subjected depended on the exterior medium when the resistance of the iron was very small, and when it got up to 20 or 30 wires, as in this case, the resistance of the magnetic circuit was almost entirely dependent on the exterior air, and not on the iron. The result that came out in theory agreed with practice, and the formula given by Maxwell was very far out indeed, for that made it depend very much on the iron.

Prof. Perry asked if the length in the case of Mr. Tanakadaté's experiments was great in comparison with the diameter.

Sir Wm. Thomson said the object of the investigation was to pursue to shorter proportions the investigations made in Japan, which ended in 30 to 1. Mr. Tanakadaté pushed down to 5 to 1 in experiments with different lengths of the same quality of wire. He (Sir Wm.) was sorry that he had not with him the exact lengths.

Prof. Perry said the result from what Prof. Rowland had said was that if you had a very short coil there was really no great object in putting the iron in it.

Prof. Rowland said he thought the iron increased the self-induction very much, but not several thousand times, as one text-book put it, not so much as the magnetic permeability of the iron would make one suppose.

* Paper read before the British Association at Bath.

ELECTROMETRIC DETERMINATION OF "V."*

BY SIR WILLIAM THOMSON, PROF. AYRTON, AND PROF. PERRY.

The standard measuring instruments used were an absolute electrometer and a centiampere balance, with a resistance coil for measurement of potential. Their indications of potential in electrostatic measure and in electro-magnetic measure were compared by aid of two electrostatic voltmeters (A and B), which had been carefully compared in Glasgow, and which were used as intermediaries. The absolute electrostatic value of the scale of one of the intermediaries (A) was determined in London by Messrs. Ayrton and Perry, using the absolute electrometer. They consider, as neither of the two instruments is capable of very minute accuracy, their determination might be three-quarters per cent. wrong, but they believe that it may be quite trusted to be within one per cent. of the truth. The voltage of the other electrostatic voltmeter (B) was determined from a potential of about 80 volts between the two ends of a resistance of 600 ohms, with a current of about 133 milliamperes through it, very accurately measured by a centiampere balance. The 80 volts multiplied 16 times by the method of condensers in series described by Sir Wm. Thomson to Sec. A at Aberdeen in 1885, gave the voltage of the B electrostatic voltmeter. As this instrument is not capable of very minute accuracy, the determination may have been wrong half per cent., but it may be trusted as probably not three-quarters per cent. wrong.

The comparison of these measurements then gave the voltage corresponding to electric potential reckoned in electrostatic units. The final result is that the electrostatic C.G.S. unit of potential is equal to 292 volts; that is to say, 292×10^8 C.G.S. units of electromotive force in electro-magnetic measure. In other words, "V" is 292×10^8 centimetres per second. This result may, we believe, be trusted to as within 1½ per cent. of the truth. It therefore seems that "V" cannot be greater than 297×10^8, nor less than 287×10^8. We present it merely as an approximate result, and look forward to measuring this very important physical constant within one-quarter per cent. by the purely electrometric method carried out by an absolute electrometer, and intermediary electrostatic voltmeters, capable of greater accuracy than the instruments which we have used hitherto.

* Paper read before the British Association at Bath.

ON RECENT DEVELOPMENTS OF THE COWLES' ALUMINIUM PROCESS.

The following is the discussion on the paper on the above subject (given in our issue of September 14th), contributed to the meeting of the British Association at Bath by Mr. R. E. Crompton, and read by Mr. G. Kapp:

Mr. R. P. Sellon asked what was the cost of working, and whether Messrs. Cowles had been able to produce pure aluminium. He thought it was open to question whether it was advisable to use only one large dynamo, because the momentum of a heavy moving mass, such as the armature core of a dynamo, did not correspond. In the case of a core not provided with teeth the displacement of the bobbins must be something enormous. But with teeth the bobbins would become loose in the long run. He thought it better to use a large number of dynamos of smaller size.

Prof. Forbes said he had lately seen this process at work. When using large currents, the commutator of a dynamo became a serious matter. He wondered why a continuous current machine had been thought better for the purpose than an alternating dynamo. It certainly seemed as if in this case the simpler alternating type would have been more suitable. He believed a still larger machine was to be built for the same works; would they still have the ventilating fan in this case? It rather reminded him of certain dynamos which had to be cooled by passing water through them, but which had long been replaced by more modern machines. With reference to the valuable new type of iron having a small percentage of aluminium in it, he would like to know whether their own manufacturers had appreciated its discovery, and whether aluminium was used for castings.

Prof. Ayrton wanted to know why Mr. Crompton adapted a series machine. Surely a shunt dynamo was better. In the latter case the load would not increase when the material fell into the furnace, and there was an increase of conductivity. He also would like to know how Mr. Crompton graduated his meter, which measured up to 8,000 amperes.

Sir F. Bramwell said that, seeing the heat was sufficiently intense to cause the material to vapourise, would not that involve a space in the mass which would interfere with the conductivity of it?

In reply, **Mr. Kapp** said that, unfortunately, he could not give figures as to the cost of the process; he had seen them, but was not at liberty to mention them. He could say, however, that it was exceedingly cheap. They could obtain pure aluminium, but only in a powdery form, with which nothing could be done. Patents were being taken out for a furnace in which they would be able to obtain

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it, though there was no great inducement to produce it owing to the limited uses to which it could be applied. It was chiefly in requisition for the valuable qualities it gave to other metals. With reference to Prof. Forbes' question as to why a continuous current machine was used, he believed the answer was, because the first experiments were made with that class of dynamo, and they did not like to go from it. As for the ventilating fan, he did not think it quite right, but when Prof. Forbes sat down to design a machine he would find it difficult to make one which would have enough cooling surface. He thought a smaller machine was more economical. Referring to a suggestion that had been made as to casting the heads of the carbons, he said that, perhaps, they might be under the impression that it was necessary to change the carbons every time they charged the furnace, but this was not so. The carbons lasted for a good many runs. There would be a difficulty in getting an even pressure round a carbon pencil. It took, perhaps, three or four days to use up the carbons. He might mention a curious fact that had not been touched on, and that was that they got a current of 6,000 amperes through an ordinary contact of two square inches, without the least sign of heating. Prof. Ayrton had asked why they did not use a shunt dynamo in preference to a series one. He was not responsible for the choice of the machine, but he thought there were the following reasons: (1) because a series dynamo did not give such very violent fluctuations of current as a shunt machine; (2) and the more important reason was that if a shunt machine was emplyed the brushes would be burnt up in a very short time. He did know how the current indicator was calibrated by Mr. Crompton. In reply to Sir F. Bramwell, the cavities did not seem to effect the conductivity. There was a good deal of charcoal lying above the charge, and as it melted out this charcoal fell down. There also seemed to be a certain power of self-adjustment, so that the average resistance was fairly constant. The addition of aluminium to iron appeared to increase both its strength and conductivity, but by how much he could not say.

The President, in proposing a vote of thanks to Mr. Crompton and Mr. Kapp, said that he had seen the process described in the paper, and it was certainly one of the most remarkable and most startling industrial operations that anyone could witness. Fireworks were not in it. The fountains of light that spurted about the place, produced by 5,000 amperes working in a small furnace, must be seen to be realised. Five thousand amperes would light 10,000 lamps. He then described how the current-meter was calibrated.

ELECTRIC ACTION ON PHOTOGRAPHIC FILMS.

At the meeting of the British Association at Bath, Mr. J. Brown showed and described figures produced by electric action on photographic dry plates. A very sensitive bromide plate was laid film side up on a sheet of metal connected to the one terminal of an induction coil; the other terminal was a wire brought down on the centre of the plate. If this wire was the negative pole, a single discharge, developed in the usual way, produced a beautiful white fan-like figure with branches carrying palm-shaped fronds; if positive, dark thinner branches, but quite different, appeared, accompanied by a quantity of light radiating tracery. If the two poles were wires, both touching on the uncoated side, different figures were produced, exhibiting the characteristics of the positive and negative terminals. A spark crossing over to the edge and the metal coating below, appears as a dark line. If coatings of tinfoil were placed on both sides of the plate after the manner of a Franklin pane, that on the film having the letters J B cut out like a stencil plate, the plates displayed the letters on dark irregular markings, apparently produced by a discharge from the metal edges, with dark blotchings corresponding to wrinkles in the foil. A piece of gutta-percha between plate and foil had no particular effect; if four thicknesses of gutta-percha intervened, the letters were no longer distinguishable, the discharge producing only irregular blotches. A careful examination of the plates discloses peculiarities which cannot be described. The whole effect may be photographic and also electrographic; the action of the gutta-percha seems to indicate that the figures are produced, partly, at least, by the direct influence of the current without the intervention of light, not only by the light itself as in the photographic process. These investigations promise further elucidation of the relations between light and electricity. Prof. Fitzgerald suggested placing the plates in a strong magnetic field. Mr. Brown had not tried this, but remarked that the effects remained the same if the plate was made to slide downward whilst the sparks were passing.

LIGHTNING CONDUCTORS.

JOINT DISCUSSION IN SECTIONS A AND G OF THE BRITISH ASSOCIATION.

(*Concluded from page 271.*)

Lord Rayleigh said he had somewhat recovered his equanimity since Mr. Preece had disturbed it by his strictures on mathematicians. There was, no doubt, a good deal of dislike on the part of the public to mathematics, much of which was due to the sufferings entailed by Euclid. Seriously, however, whatever might be the failings of individual mathematicians, it was to mathematics they must go if they wanted to foresee what would be the operation of known causes under new and unfamiliar conditions. Mr. Preece had spoken of the mistakes mathematicians had made, and no one could deny that they had made some. Dr. Lardner would not, however, be recognised as a great mathematician, and he it was who made the prophecy about crossing the Atlantic. The only book of his he (Lord Rayleigh) had read was rather an engineering book than a mathematical one. They all knew that engineers had important work to do, and they must admit that there was work, also, for the mathematicians to do which the engineers could not. He had no experience whatever of lightning conductors, and could only speak from a general knowledge of electricity. He must say, however, that Prof. Lodge's experiments were likely to have a most important application to lightning conductors. Dr. Lodge had asked how it was that an oscillating current which gradually died away could magnetise needles as it did. The question was a difficult one, and he had intended to make experiments on it. He believed it was well known that at different depths in a steel needle they would find different degrees, and even different directions, of magnetisation. If the matter were followed out, no doubt they would be able to ascertain that alternating currents did leave behind strong magnetisation. Mr. Preece had spoken of the great energy they had to draw upon in the condensation of large quantities of vapour into water, but the difficulty was to see how that energy took an electric form. He had been reading a pamphlet by Prof. Gainger, in which he developed the theory that atmospheric electricity was due to the friction between water and ice. No doubt many clouds were ice-clouds and not water-clouds, and this was proved by the peculiar optical effects produced by ice crystals. There was no difficulty in distinguishing the one from the other. The professor he had mentioned thought that the ice and water clouds might meet at a certain level in the atmosphere and produce electricity. That was, perhaps, not the main question before them, and he would rather hear the experience of practical men who had worked on lightning conductors. It seemed to him that it was only by actual experience of conductors that the question would ever be settled.

Sir William Thomson said he had been somewhat in the state of a highly charged lightning phial, to which Lord Rayleigh had acted as a conductor. He would say emphatically that it was not a mathematician, but a very great engineer who had predicted that the Atlantic cable could not be laid. He well remembered how one very great engineer had been convinced that it was impossible for the guttapercha to stand the pressure. Speaking of the very great difference between Dr. Lodge and Mr. Preece, he thought that Dr. Lodge was in the American stage with reference to the functions of inertia, as defined by Prof. Ayrton, and that both the English and American functions were very much implicated in the matter. He hoped Prof. Lodge would pursue his investigations on the relative values of iron and copper wire as paths for the discharge, and would compare iron with lead and brass wire of the same ohmic conductivity. He could not help thinking that a proper account must be taken of inertia, yet energy must be got rid of somehow. If in the conductor, then there must not be too much energy to melt it. Thus it might be of great advantage to have quasi-inertia to prevent the conductor melting. Having alluded to the well-known lecture experiment of administering a shock to a circle of persons, in which the two end ones feel the effect most, Sir William Thomson went on to suggest a modification of this. If the row or circle was made into a zigzag, then self-induction would not have the same tendency to cause the discharge to leave the line of the best conductors, as it would if the conducting bodies were placed in a wide circle. With respect to ball lightning, the appearance of which had been very graphically described by many people, he did not quite believe the stories told. When people talked of a ball passing along the floor, up the wall, and out at the window of a room such as that they were then in, he was inclined to think it was altogether a physiological affair, and that there were as many balls as windows. He thought Mr. Preece was quite right in speaking of the multiplicity of flashes of lightning. The first time he noticed it was in 1840, when he noticed treble and quadruple flashes recurring at such short intervals of time that he could not but think them connected. He had also seen them since. It did not seem to be a repeated flash along one course, but that one flash caused many others. Light had been spoken of as having something to do with it, but that would not account for the time interval between flashes. He thought there must be something in the velocity of sound to account for it. This might be experimented on. Taking up one of the photos, Sir William Thomson said that they had three flashes in one photograph. Query, were they simultaneous? [**Mr. Abercromby** said they had no evidence of it.] Then he thought it would be worth while to endeavour to ascertain this by experiment. He would suggest the putting out of four cameras side by side, with revolving shutters, one exposed when the other was cut off—then it was easy to see that they could make any time analysis they pleased. By this arrangement they could afford to lose a considerable number of flashes. But, to do the thing properly, they ought to lose none; and then the cameras would tell their own tale as to whether the flashes were simultaneous or not. With regard to the magnetisation of steel needles in a helix in which there were electric oscillations, Preece had experimented on this subject prior to 1854, and found that he could magnetise needles by placing them in a helix through which a Leyden jar was discharged. It was rather disturbing to find that a lightning-rod had so little protecting power as Prof. Lodge had pointed out it seemed to have. With reference to his distinction between iron and copper, he would like to ask Mr. Preece whether he had any experimental evidence of the superiority of copper. Were some of the iron conductors efficacious as well as the copper? Owing to the higher melting point of iron, it would allow for the consumption of a great deal more energy than copper, but they must experiment before they could decide between the two. One conclusion to be derived on the matter was, that a sheet-iron house was the very safest place in a thunderstorm. It must have iron roof, iron floor, in fact be iron throughout. It seemed as if the current could not get into the inside. Powder magazines so constructed would require no conductor at all and would be quite safe. That much, at all events, might be concluded from these electric oscillations and mathematical calculations of which they had heard so much.

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Prof. Rowland said that it was a question whether Prof. Lodge's experiments represented the case of lightning. In these experiments the whole of the circuit between the condensers was of copper or iron wire; whereas in the case of lightning the greater portion of the flash was in the air. So lightning might be a different phenomenon to that observed in the experiments. As to the length of the spark, he did not think that was much to go by, as they did not know what the length of the spark was when there was an oscillating E.M.F. acting on it. The oscillation might take place before the spark did, and so the length of the spark might not be an index of the temporary resistance of the conductor to its passage. He thought the fact should be remembered that in the case of lightning the greater part of the discharge was in air, and so it might not be oscillatory. In the photographs he noticed many curious phenomena that should be guarded against. The best one there was an American one, in which the whole plate was exposed, and the lightning in the centre. Probably many of the photos had more than one flash on it. In some of them, as the eye wandered from the centre it saw a number of hazy effects, which might be due to astigmatism of the lens.

M. de Fonville addressed the meeting in French, and was understood to say that he was of Mr. Preece's opinion as to the efficacy of the present system of lightning conductors and protectors. They had used them in Paris for many years, and no one had been hurt. There was a great difference between the conditions under which experiments were carried out in the laboratory and those which obtained out of doors.

Prof. George Forbes thought Mr. Preece would admit that the conclusions of the mathematician were absolutely correct, and could not be wrong, when he was accurate in his choice of data. With reference to Prof. Lodge's experiments, he thought it was quite fair for Mr. Preece to say that they had not proved that the conclusions of the conference on lightning rods ought to be given up. He would suggest to Prof. Lodge that he should use in his experiments the two poles of a Holtz machine instead of condensers, or instead of two pairs of knobs he should use only one pair. He thought the conditions then would be more natural, and that the copper alternative path would prove the best.

Sir James Douglass offered a few remarks relating to his experience of conductors, which extended over 40 years, and was comforting to the conference. In erecting the conductors of the lighthouse towers under his supervision, they had followed the advice of Faraday. These conductors were 1¼in. by ¼in., and were carried down the interior of the tower, with branches from all metal work therein. Earth was obtained by a copper plate 2ft. 6in. square and ¼in. thick. On land a damp contact was secured in the usual way, but at exposed stations at sea the conductor was carried down to about 8 or 10ft. below spring tides. During 40 years, perhaps, seven or eight accidents had occurred, but none of a serious nature, and in all cases they had been able to discover a defect in the conductor. These defects were to be got over by more rigid inspection, and this was now being carried out. He himself would feel perfectly safe in a tower. One point in the controversy between iron and copper was the rapid corrosion of the former as compared with the latter. He had known bars of large diameter to corrode in the most rapid way possible, and this corrosion was more rapid in hotter climates than theirs. He had the utmost confidence in good copper conductors. In all the cases in which they had fitted conductors to towers during the last forty years they had never protected the dwellings near, and only in one case had an accident occurred to surrounding houses, and there it was due to an imperfection in the conductor.

Mr. S. F. Walker, who spoke from the point of view of a practical engineer, said that whatever might be the outcome of the discussion, it was the engineer who would have to carry out the work, and who would get the abuse if it went wrong. He knew of an instance in which a chimney was destroyed in Derby where it was cheaper to allow its destruction than to put up a conductor. They would gladly welcome anything that would cheapen lightning conductors. If a conductor were properly erected anything it was attached to was absolutely protected, and there was no instance of a building being damaged where these conditions had been complied with. The crux of the whole thing lay in the earth connection. A conductor ought not to be leaded into a tombstone, or anything of that sort, but should be carried to the gas or water mains, when the sectional area was enormously increased, and this had a very great bearing in side flash. He thought it would be seen that the resistance of the conductor was a very small part of the resistance, as a whole, opposed to the cloud, and therefore the difference between the resistance of iron and copper was not a very serious matter. Points, of course, the engineer would provide in any case. As to self-induction, he thought Ohm's law was not dead and that self-induction was only an old friend with a new name. He did not think iron would be as good as copper for conductors, especially for chimneys, the top bricks of which were often red hot, or for works where it would be liable to chemical deposits. He thought the fact that cattle were often struck in the fields without any apparant reason, had been overlooked. That might be due to the passage of electricity within the earth's crust.

Mr. Brown thought the question of the sequence of several flashes could easily be determined by setting up one stationary camera, and having another revolving.

Mr. Symons, secretary of the Meteorological Society, said he had devoted his attention to the question of thunderstorms for over thirty years. He had nothing to do with the construction or erection of lightning conductors, but he had contracted a habit of investigating the results of damage by lightning for many years. He was also one of the members of the conference. He must say he was in accordance with Sir James Douglass. If people would only put up conductors in accordance with the rules given in the report, these would be absolutely safe, and he had no hesitation in saying so. A reasonable explanation of all accidents was forthcoming. They all knew it was much easier to produce destructive than constructive criticism. It had often occurred to him that if on the summit of some of those hills which were most frequently struck a series of conductors were put, they might learn a good deal more than they knew at the present day. He would like to see conductors cheapened, but he did not wish any expression as to their safety to go forth from that association. One of the speakers had made fun of ball lightning, but he had often heard of and seen it, and did not deny its existence, though he could not understand it. With reference to iron conductors, he did not think the question of oxidation could be met by galvanising. He alluded to St. Asaph Cathedral, where the conductor was leaded into a pickle bottle, as an illustration of how not to obtain good earth. With respect to the use of small wires for conductors, he could only say that he had been in houses which had been struck by lightning, and found the bell wires deflagrated, which fact, he thought, was rather adverse to the proposal.

Mr. Walker alluded to the fact that an obelisk placed on the top of a certain hill had been destroyed by lightning, he being half a mile from it at the time. The whole air seemed filled with light, and there was no flash. The lightning seemed to pour out in streams from the angles of the steps at the base of the obelisk, and split rocks at a distance from them. The Monument had been twice struck.

In reply to **Mr. Preece, Mr. Walker** said it was not provided with a conductor.

Mr. H. T. Wood said, with reference to the dark flash spoken of by the Hon. Mr. Abercromby, that, whatever it might be, it was certainly not the result of over-exposure, because the white flash overrode the black one. In another photograph there was another exactly similar line, which was the result of reflection from the back of the plate.

Lord Rayleigh agreed with Mr. Wood that the black flash was not due to over-exposure.

Replying to the observations that had been made, **Prof. O. J. Lodge** said that Mr. S. F. Walker and Mr. Symons had spoken as if he had specially attacked the report of the Lightning-Rod Conference, but he had not done so. He had made great use of it, and he thought the conference had done a very good work. A properly constructed lightning-rod never failed. Why a thing ought to have such good earth he could not tell. Why should it not be up-ended, and have its roots in the sky? They ought to have a good earth, but however bad the earth—so long as the conductor went down to it—a flash ought not to spit off therefrom. As regarded the failure of properly constructed conductors, Why did M. Melsen's Hotel de Ville get set on fire? He (Prof. Lodge) thought it was sufficiently protected. When he said that no building was perfectly and completely safe, he never thought of meaning that the conductors were of no use. It was usual to protect a lightning post or obelisk. The Monument in London was protected, the staircase forming the conductor, and that had not been damaged. It was not so easy, however, to protect a house or powder magazine. Prof. Forbes asked him to say why he did not use one pair of knobs instead of two pair in his experiment; his answer was that it could not be done with one pair. There must be an alternative path for the air gap. The reason why iron was better than copper was that it was only the outer surface of the conductor that conducted at all. It was a tube of current which flowed, and therefore the conductor did not get magnetised at all, whether it was iron or whether it was copper. The current from even a gallon Leyden jar was very great, and so was that from a lightning flash, and so the impedance was very great. Seeing that it was only the outer surface which conducted, what was the use of the inside of a rod? Probably it was no good, but they had better have a pair of rods, and if one pair, then it was better still to have several strands of wire. Mr. Preece knew very well that the iron wire on the telegraph posts protected them very well. The failures of lightning conductors were due in most cases to the spitting off of the flash owing to the impedance of the conductor, and not to its melting. Mr. Symons, in the report, gave an appendix, K, of lightning conductors which had been melted, and apologised for the shortness of the list, and in almost every case it was the upper terminal that had been melted, and not the whole conductor. Iron buildings were practically safe for powder magazines, but even with them something else was wanted. If there was a gap left anywhere, there would be a spark at that point. They might have sparks at any place, and for the most ridiculous reasons. It was the danger of sparks ¼in. long that had to be avoided in houses and powder magazines. With regard to the possible effect of sound waves he would call attention to an experiment of Dr. Guthrie's, in which a tube filled with powder was placed with reference to the discharge knobs of an influence machine. When the spark had passed it was found that the powder in the tube had taken the form of longitudinal waves—sound waves, in fact.

Mr. Preece then rose to reply. His allusion to Balaam had been unfortunate. According to Prof. Lodge, there were three quantities concerned. Balaam, Balak, and the ass, but there was also a fourth, the voice, and it was with this that he wished to associate himself. Prof. Forbes had put his views with regard to mathematicians and engineers on the right footing. He would not like to call in question anything that such masters as Lord Rayleigh, Sir William Thomson, or Prof. Rowland said. No doubt they all made mistakes, but the people he meant to implicate were a lot of young students who had had some technical instruction, and who were always writing to the papers, their effusions being printed because the latter were glad of the matter. He wished to point to the necessity of being excessively cautious unless mathematical deductions were confirmed by actual experience. A true mathematician would never come to a conclusion unless he was sure of his ground. There would be other occasions on which the point raised in that discussion could be argued. Lots of his conductors were of iron, and he had always been a great advocate of iron. He thought copper was a needless expense in conductors. His own impression was that every house could be protected if anyone could buy an iron stranded rope ¼in. in diameter and having finial

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points, as mentioned by Mr. Symons and given in the report, for a few shillings instead of as many pounds.

The **President** then summed up the result of the morning's considerations. He had had no experience of lightning, which was not an agreeable thing, but it was most closely allied to statical electricity, and he hoped that experiments would gain fresh interest from the practical results likely to be derived from them. He thought that, so far as Dr. Lodge was concerned, it was most important to notice the effects that were produced by flashes at telephone and other stations. [**Mr. Preece** remarked that they had experienced the effects referred to at their telephone and electric light stations.] He was inclined to think that Dr. Lodge's experiment was not analogous to a lightning flash. The conditions under which the latter occurred where much more like the breaking down of the insulation of a condenser. [**Dr. Lodge** said that if the President would read his paper he would find that experiment carried out.] He would like to remark that globular lightning might be due to the combination of atoms of air, the original dissolution of the atoms having been produced by electricity. He thought that, as regards photographs of lightning, the suggestion of Sir F. Bramwell to have a long strip of sensitised paper carried up at the end of the camera, was better than the idea of a revolving shutter. In conclusion, he thought the principal thing for them to pay attention to was, that prevention was better than cure. As M. de Fonville had said, the presence of a great many conductors afforded protection over a large area, and owing to this they had had very few accidents in Paris. It was very desirable that the whole country should be covered by lightning conductors, so as, if possible, to prevent the occurrence of lightning. When a flash did occur it was a very disagreeable thing, and in that case absence of body was better than presence of mind. There was no doubt, quite independent of any experiments, that conductors had protected buildings; and, whatever the explanation of this might be, there was no doubt that on the whole they had been right, and that conductors had been a great protection to mankind from lightning.

COMPANIES' MEETINGS.

MAXIM-WESTON ELECTRIC COMPANY.

An extraordinary general meeting of this Company was held on Wednesday at the City Terminus Hotel, Mr. John Marks presiding, to consider a resolution reducing the capital of the Company from £125,000, in shares of 5s. each, to £62,500 in shares of 2s. 6d. each, the reduction to be effected "by cancelling capital which has been lost, or is unrepresented by available assets to the extent of 2s. 6d. per share upon each of the 312,000 shares which have been issued and are now outstanding, and by reducing the nominal amount of all shares in the Company's capital from 5s. to 2s. 6d. per share."

The **Chairman** reminded them that at the meeting last March, when Mr. Hugh Watt, M.P., the then managing director of the Company, moved the adoption of the report and accounts, Mr. Swaby, the only then remaining director besides Mr. Watt, proposed the rejection of the report and accounts on the ground that they were altogether untrue. That led to some discussion, and a committee was appointed to inquire into the affairs of the Company and to report thereon to a subsequent meeting. The result of their investigation was that they reported to the shareholders that the balance-sheet presented by Mr. Watt was untrue, and they recommended the shareholders to appoint additional Directors to act with Mr. Watt in carrying on the affairs of the Company in the future. At a meeting on the 19th July, at which Mr. Watt presided, five gentlemen were proposed as new Directors, and their names, which were put to the meeting by the Chairman, were unanimously agreed to. The new Directors at once set to work, and it was arranged that a Board meeting should be held on the 21st July. Mr. Watt was not present, and the Directors asked the Secretary to produce the books and documents belonging to the Company. The Secretary replied that they were locked up in the safe, and that Mr. Watt had the key. They therefore could not transact any business that day. The Secretary, when asked what he had to report, stated that a cheque for £724 had been received from a certain client. It had been received some days previously, but it had not been entered in the cash-book, nor had it been paid into the bank. On their making further enquiries the Secretary informed them that he had endorsed the cheque and given it to Mr. Watt, who had paid it into his private account, stating that the Company were indebted to him (as they were). Mr. Watt had, however, written a cheque in favour of the Company for £74, retaining £650, against which he claimed as being due to him by the Company. Another Board meeting was arranged for the 27th July, at which Mr. Watt was present, but he positively refused to let them have access to the minute-book and other documents of the Company, stating that he very much questioned the validity of the new Directors' election, and that till he had obtained a legal opinion on the point he would refuse to give them any assistance in carrying on the business of the Company. On behalf of the new Directors, Mr. Emden was consulted, and his opinion was that they were legally Directors of the Company, and had a right to carry on the business of the Company on behalf of the shareholders. Mr. Watt's resignation was accepted. The Secretary refused to carry out the instructions of the Board, and would only receive Mr. Watt's instructions, and therefore they dismissed him. From further inquiries of the Directors it appeared that the whole staff of clerks at Mr. Watt's offices were the clerks of Mr. Watt, doing the clerical work of the company, and of the Yuruari, the New Chile, and the Port Darwin Mining Companies, while the particular clerk, who received the largest salary, was also doing the private correspondence of Mr. Watt with his constituents in Glasgow. Referring to the examination of the books of the company by Messrs. Boyce and Ramsay, he reminded the shareholders that in the annual balance-sheet the profit of the year was put down at £1,555, upon which Mr. Watt claimed a commission of 5 per cent. The patents, however, had been written up to the extent of £2,507 in a manner which he (the Chairman) questioned. Then, as to stock, according to the valuation of the works' manager, the stock and plant should have been stated in the balance-sheet at £15,000 instead of £23,649, or an over estimate of £8,000. As to the debtors, they felt satisfied of the accuracy of Messrs. Boyce and Ramsay's estimate, that £7,600 should be written off for bad and doubtful debts, notwithstanding Mr. Watt's statement at the meeting in March last that the whole of the debts were good and recoverable. After writing down the assets as suggested, the Board believed that they would represent about 2s. 6d. a share. It was therefore proposed to write down the shares to that amount, and at the same time the shareholders were asked to take up 188,000 unissued shares at 2s. 6d. each. Unless capital were provided they would have to consent to the petition which Mr. Watt had presented for the liquidation of the Company. They believed, however, that with the new capital which the issue of the balance of the shares would give them, they would be able to place the Company on a sound footing to undertake the really profitable work which had been offered to them. After referring to the improved prospects of the electric lighting industry, he alluded to a circular which had been issued by Mr. Watt, and replied at considerable length to the statements which it contained. He concluded by moving the resolution above mentioned.

Mr. J. M. Kleneck seconded the motion, which, after some discussion, was carried.

Resolutions were afterwards passed authorising the Directors to oppose the winding-up petition, and to take such proceedings as they might be advised to adopt against Mr. Watt for recovering the money alleged to be due by him to the Company.

DIRECT SPANISH TELEGRAPH COMPANY.

The 30th ordinary general meeting of this Company was held on Tuesday, at Winchester-house, Old Broad-street, Sir James Anderson presiding.

The Chairman reminded them that at their last meeting he held out the hope that they would soon be able to pay a dividend on the ordinary stock of 5 per cent. per annum. He was very glad now to be in a position to state that they had reached that point. The traffic receipts of the half-year ended the 30th of June last had exceeded those of the corresponding period of 1887 by £851, but they had had to incur an additional expenditure of £260. With regard to the working of the current half-year, although in the first three months they had carried 2,000 more messages, they had received no more money. That had arisen from the growing habit of using codes for messages, and from the fact that the traffic was being influenced by the advance of the tariff on the American lines. He did not despair of being able to maintain the dividend now recommended, for their traffic—which was sound and commercial, and not political or spasmodic—was growing. Everything was going on well with their undertaking, and their cables were all in good order. He concluded by moving the adoption of the report.

Mr. Edmund Etlinger seconded the motion, which was adopted, the dividends recommended being also approved.

CITY NOTES.

West Coast of America Telegraph Company.—The traffic receipts of the West Coast of America Telegraph Company for September amounted to £4,875.

Brazilian Submarine Telegraph Company.—The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ending September 28 amounted to £4,788.

West India and Panama Telegraph Company.—The estimated receipts of the West India and Panama Telegraph Company for the half-month ended September 30 were £2,034.

Direct Spanish Telegraph Company.—The estimated traffic receipts of the Direct Spanish Telegraph Company for September were £1,888, against £1,996 for the corresponding period of last year.

Western and Brazilian Telegraph Company.—The traffic receipts of the Western and Brazilian Telegraph Company for the week ending September 28, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Company, were £3,947.

Eastern Telegraph Company.—The Eastern Telegraph Company, Limited, announce the payment, on October 15, of a dividend of 3s. on the preference shares, less income-tax, for the quarter ending September 30, and an interim dividend of 2s. 6d. on the ordinary shares, tax free, in respect of profits for the quarter ended June 30.

Eastern Extension, Australasia, and China Telegraph Company.—The report of the Eastern Extension, Australasia, and China Telegraph Company, Limited, for the half-year ended June 30 states that the gross receipts, including Government subsidies, amounted to £239,926, against £219,201, the working and other expenses, including £22,112 for cost of repairs to cables and expenses of ships, being £69,297, against £76,241. The net profit was £125,804, against which the balance of cost of the Singapore-Sagou renewal, amounting to £15,401, has been charged, leaving an available sum of £110,403. One quarterly dividend of 1¼ per cent., amounting to £31,250, was paid, and another of like amount will be distributed on the 16th inst., leaving £47,903 to be carried forward

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NEW COMPANIES REGISTERED.

The Medical and Scientific Apparatus Company, Limited.—Registered by White and De Bareath, 38, Holborn-viaduct, London, E.C., without articles of association, and therefore the clauses of the first schedule of the Companies Act, 1862, will apply. Capital, £1,000, divided into 1,000 shares of £1 each. Object: to adopt an agreement to purchase from Thomas Phillips Christopher Crampton the letters patent, or provisional protection granted to him for improvements in chemical thermometers, &c., and to carry on the business of electricians, electro-depositors, and manufacturers of and dealers in scientific instruments.

PROVISIONAL PATENTS, 1888.

SEPTEMBER 21.

13,629. **Improvements in brush holders for dynamo-electric machines.** William Harding Scott, 64, Hall-road, Lakenham, Norwich.

13,643. **Improvements in circuit making and interrupting devices for electric bells and other purposes.** William Snelgrove, 13, Temple-street, Birmingham.

13,653. **An electrical automatic money call-box.** Edward Richard Widdicombe, 5, Bath-terrace, Neville-road, Forest Gate, Essex.

SEPTEMBER 22.

13,687. **Improvements in and connected with electrical furnaces.** Rookes Evelyn Bell Crompton, Arc Works, Chelmsford.

13,713. **Non-magnetizable balance for watches and chronometers.** Daniel Buckney, 5, King-square, Goswell-road, London, E.C.

13,720. **Improvements in the construction of lightning conductors for the protection of buildings.** Samuel Alfred Varley, 2, Hamilton-road, Highbury, and George Driver, 210, Euston-road, both in London.

13,725. **Improved means or devices for making electrical contacts in coupling-up electric conductors.** Thomas Meriton Sargeant and Oswald Ricketts Swete, 47, Lincoln's-inn-fields, London.

SEPTEMBER 24.

13,778. **Improvements in telephone central station apparatus.** Theodore Newton Vail and John Ashby Seely, 321, High Holborn, W.C. (Complete specification.) (Date applied for under Section 103 of the Patents, &c., Act, 1883, 25th February, 1888.)

13,779. **Improvements in telephone sub-station apparatus.** Theodore Newton Vail and John Ashby Seely, 321, High Holborn, W.C. (Complete specification.) (Date applied for under Section 103 of the Patents, &c., Act, 1883, 25th February, 1888.)

SEPTEMBER 25.

13,805. **Improvements in the application of electricity to vehicles on tram and railways, and in the apparatus for effecting the same.** Frank Wynne, 5, Westminster-chambers, Westminster.

13,825. **Improvements relating to electrical conductors and insulating conduits therefor.** Henry Harris Lake, 45, Southampton-buildings, London, W.C. (Robert F. Silliman, United States.) (Complete specification.)

SEPTEMBER 27.

13,937. **Improvements in transmitters for telegraphic purposes.** Philip Neil, 4, South-street, Finsbury, London.

COMPLETE SPECIFICATIONS ACCEPTED.

OCTOBER 7, 1887.

13,605. **An automatic coin-freed dynamometric machine for testing physical power, and for delivering prepaid goods on a certain amount of power being applied.** Jean Conte, 68, Fleet-street, London.

NOVEMBER 3, 1887.

14,996. **Improvements in gear for transmitting motion from electric motors to driving axles of vehicles.** Edward Hopkinson, 47, Lincoln's-inn-fields, London.

NOVEMBER 11, 1887.

15,445. **Improved means for electrically controlling the speed of steam engines.** Edward Jones, 6, Bream's-buildings, London, E.C.

NOVEMBER 17, 1887.

15,760. **Improvements in the electrolytic treatment of sewage and sea water for the production of certain products therefrom, and apparatus therefor.** William Webster, jun., 28, Southampton-buildings, Chancery-lane, London, W.C.

NOVEMBER 18, 1887.

15,877. **Improvements in telegraphic apparatus suitable for indicating the position of a ship's rudder.** James Bonelle Willis, 24, Southampton-buildings, London, W.C.

NOVEMBER 24, 1887.

16,185. **Improvements in electric meters.** William Joseph Starkey Barber-Starkey, 1, Queen Victoria-street, London, E.C.

DECEMBER 6, 1887.

16,772. **Improvements in electric bells.** James Alexander Macdonald, 25, Clifton-road, Birkenhead.

JUNE 12, 1888.

8611. **An improved form of galvanic belt for medical purposes.** William Laughton, 118, Camden-road, St. Pancras, N.W.

SPECIFICATIONS PUBLISHED.

1887.

13,960. **Combined spring jack and lightning arrester for use with a test board for telephone wires, &c.** A. Coleman and H. F. Jackson. 8d.

14,390. **Electric firing fuse.** R. Morris. 8d.

14,528. **Microphones.** C. Bell. (Ericsson.) 8d.

14,529. **Microphones.** C. Bell. (Ericsson.) 8d.

14,658. **Electric indicators.** G. E. Fletcher. 8d.

1888.

6614. **Electrical illumination of clock dials, &c.** E. G. Craven. 8d.

10,691. **Electrical transmitting instruments.** A. J. Boult. (McLaughlin.) 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	3
12 Feb.	2/0	— fully paid	5	4
27 July	1%	Anglo-American	100	48
27 July	2%	— Pref.	100	79¾
12 Feb., 85	5/0	— Def.	100	17
28 June	3/0	Brazilian Submarine	10	18½
14 June	1/0	Con Telephone & Main	1	1⅛
10 Aug.	9/0	Cuba	10	13¾x
10 Aug.	10/0	— 10% Pref.	10	18½
28 Mar.	2/2½	Direct Spanish	5	4⅛
28 Mar.	5/0	— 10% Pref.	5	10¼
27 July	2/0	Direct United States	20	10⅝
27 July	4/6	Eastern	10	12¼
27 July	3/0	— 6% Pref.	10	15
1 Aug.	5%	— 5%, 1899	100	110
26 April	4%	— 4% Deb. Stock	100	110
12 July	2/6	Eastern Extension, Australasia & China	10	13 1/16
1 Aug.	6%	— 6% Deb., 1891	100	104½
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	103
28 Mar.	8/3	German Union	10	9½
10 Aug.	3/0	Globe Telegraph Trust	10	7¼
10 Aug.	3/0	— 6% Pref.	10	14¼
30 April	5/0	Great Northern	10	14

Dividend.		Name.	Paid.	Price. Wednesday.
1 March	5%	Gt. Northern 5% Deb., '83.	100	109
27 July	10/0	India Rubber, G. P. & Tel.	10	17 1/16
11 May	37/6	Indo-European	25	39
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
		Swan United	3½	2¼
10 Aug.	13½%	Submarine	100	140x
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39½
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	99
12 July	4/0	West Coast of America	10	8
30 June	8%	— 8% Debs.	100	115
11 May	9/0	Western and Brazilian	15	12⅝
11 May	6/10½	— Preferred	7½	7¼
11 May	2/1½	— Deferred	7½	5½
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	1⅛
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80		— 6% 2nd Pref.	10	10⅝
2 May	7%	West Union of U.S.	$1,000	125
1 Mar.	6%	— 6% Sterling	100	102

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NOTES.

Pupil.—A pupil is wanted without premium at Taunton—see our advertisement column.

Montpellier.—The new theatre at Montpellier, just opened, is lighted throughout with electric light by M. Popp.

Dinner.—The Old Students' Dinner takes place to-morrow—Saturday—at the Holborn Restaurant, 7 p.m.; tickets, 4s. 6d

Fulham Vestry.—The solicitor to the vestry has been instructed to oppose the proposed bills to supply the parish with electricity.

Alpignano.—The central station at Alpignano, Italy, using Cruto incandescent lamps, was opened on the 23rd September last.

Twenty-Six since February.—The Sprague Company has closed its twenty-sixth contract for electric railroads. On February 1 not a single line was in operation.

Personal.—Mr. G. S. Hocker has resigned his position at Taunton, to take charge of the Bath installation, and Mr. O. V. Thomas has been appointed electrician-in-charge at Taunton, in his place.

Indo-European.—Mr. J. Herbert Tritton was unanimously elected chairman of the Indo-European Telegraph Company, at a board meeting on Monday, in succession to Colonel Holland, who has retired, owing to his advanced age.

Worth of the Dynamo Regulator.—It is said the right to use the dynamo regulator, which was the bone of contention in the suit won by the Thomson-Houston Company against the American Company, is worth 1,000dols. a day.

Testing with Wimshurst Machine.—A large Wimshurst machine, with eight 30in. plates, has been built by Mayfield, Cobb, and Co., to be used for testing the primary circuits of the Grosvenor Gallery with a high-tension spark.

Electrical Forcing of Plants.—A tree at Fairfield, U.S.A., under the direct rays of an arc light has visibly distanced its companions in growth and continues to grow rapidly. This fact has called attention again to the probable application of electric light in forcing.

The Noise of Motors.—To obviate the noise from the motors, the Sprague Company is attaching a wood fibre substance to the gearings, making them absolutely noiseless. The fibre, by a peculiar process, though it is composed entirely of wood, is rendered as hard as steel.

Electric Drill.—An electric drill, weighing 100lb., and that makes a hole .3ft. deep in hard anthracite in thirty seconds, and one 6ft. deep in 1½ minutes, is the latest thing in electric drilling-machines. It is designed by Mr. W. M. Schlesinger, and made by the Union Electric Company, of Philadelphia.

City Lighting.—The Streets Committee have commenced to deal with the matter of City lighting, and have instructed their engineer to report so that the committee could draw up conditions under which the electric lighting companies might be asked to tender. Applications have already been received, but are adjourned till the engineer's report is received.

Plymouth.—Plymouth is a town where electric lighting should extend usefully in spite of the cheapness of the gas. Since the brilliant lighting of the New Pier nothing much has been done in this important seaport town; but a better spirit is showing itself, and we hope something will be done.

Paddington.—At the Paddington Vestry meeting last Tuesday, the Electric Lighting Committee, having considered the report of Mr. S. J. Mackie, thought it would be to the interests of the parishioners to take the necessary steps to apply for a provisional license for electric lighting this year. This was put and carried.

Statue to Ampere.—The French Academy has been invited by the Mayor of Lyons to be represented at the ceremony of unveiling the statue raised in honour of André Marie Ampère, the noted electrician, which is to take place in a few days. M. Cornu has been appointed to represent the Academy at the ceremony.

Prophetic.—Our contemporary can't drive a dog-cart, perhaps, but it can get news sharp. The long distance telephone, it says, between New York and Chicago is in daily operation. This, however, we hear from Chicago is regarded as a great piece of news at that city. The line is certainly building, but the opening of it by the English paper is—well, ahead.

Nothing Succeeds like Success.—The sale of Dr. Gassner's dry cells is already well into the thousands, and has been greatly used for ship and house bell work, for medical purposes, and for portable bells. For the latter purpose the dry cell is, of course, without rival, by reason of the ease by which it can be carrried about in the pocket or placed in any position.

Electric Race Timing.—An ingenious Yankee has invented a combination clock, camera, and electric signal for accurately timing races. The clock is graduated in minutes, seconds, and fifths of a second. When the winner touches the wire, the clock is stopped by electricity, and the current opens an instantaneous shutter of a camera, which photographs the winning horse, or bicycle, &c., together with the clock face. A similar arrangement was used last week in France.

An Example to Gas Companies.—The gas company of Lawrence, Kansas, recently purchased seventy 2,000 candle-power arc lamps from the Thomson-Houston Company. A fine new stone building has been erected by the gas company for the accommodation of the new plant. Motive power from the Kansas river will be used for about nine months of the year, but the company has steam power at hand whenever necessary. It is the intention of the gas company shortly to add 1,000 incandescent lights.

The Chelsea Station.—The central station at Chelsea, which is being established by the Brush Corporation as contractors for the Chelsea Electricity Supply Company, will consist of plant, in the first instance, sufficient to supply 6,000 lights. The electricity generated at the central station will be conveyed by underground mains to sub-centres, where accumulators, which the Electrical Power Storage Company are supplying, will be charged. From these storage stations the current will be distributed to the surrounding buildings.

Schanschieff.—The Schanschieff battery is making good way. Numbers of batteries are selling for private

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room and office lighting, for both portable and fixed lamps, a new 16-cell battery for two 12 c.p. lamps being largely employed. One or two larger installations for 30 lamps have been undertaken in the City, and a great deal is being done with the Schanschieff four-cell miner's lamp, which is being introduced in a great many collieries. The Schanschieff battery is also largely used for driving small motors, and a considerable quantity have been supplied to Colonel Gouraud for driving the Edison phonograph.

Accumulator Reviver.—Mr. Charles Topham, Salem, Mass., chemist of the Canton Manufacturing Company, is credited by *Modern Light and Heat* with a compound for "keeping alive storage batteries." He has a liquid he injects into the battery, and he "has used an old-worn out battery four weeks without perceptible diminution of power." He is said to have shown his experiments very successfully to Sir Lyon Playfair recently. By this it appears all one wants for an installation is a set of old accumulators and some injection, and the dynamo and engine is dispensed with. We wonder what Sir Lyon Playfair thought of it.

St. George's Vestry.—The St. George's Vestry have appointed an influential Electric Light Committee to deal with the question of lighting the district. It was agreed that the committee consist of thirteen members, and that the following gentlemen, who were members of a former committee, be elected members—viz.: Mr. John Dovey, Admiral the Hon. A. Duncombe, Sir William J. Farrer, Lord Frederick Fitzroy, Lord Hobhouse, and Admiral Sir George Wellesley. The following gentlemen were also elected: The Hon. Alan de Tatton Egerton, M.P., Mr. Southon, Mr. Cove, Mr. Antrobus, Mr. Williams, Mr. J. Finch, and Mr. Adkins.

Birmingham.—A special meeting of the Town Council will be held, in accordance with the Act, on the 9th of November to consider the notice given on behalf of Messrs. Chamberlain and Hookham, of New Bartholomew-street, Birmingham, that it is their intention to make application to the Board of Trade in pursuance of the Electric Lighting Acts 1882 and 1888 for a provisional order, to be confirmed by Parliament in the next ensuing session; and also to authorise the General Purposes Committee to adopt such proceedings on behalf of the council as may be necessary for supporting or opposing the said application as the council shall determine.

Alternate Current Electrolysis.—Referring to the recent experiment by Chappuis and Maneuvrier in Paris on the decomposition of water by alternate currents, it is pointed out in *Nature* that the whole question was thoroughly threshed out by Sir W. Thomson in 1853, and his paper in the June number of the *Philosophical Magazine* of that year gives all that it is necessary to know on the subject. Jamin, in 1882, showed how electrolysis could be performed by alternate currents by inserting an arc in circuit, the opposing E.M.F. of the arc producing a partial rectification of the currents. Mr. J. F. Kelly has just repeated the experiment in Newark, U.S.A.

Brush Lamps on Incandescent Circuit.—It may sometimes happen that a single arc lamp is required to be run temporarily from an incandescent circuit. A correspondent of the *Western Electrician* describes a primitive arrangement for this purpose. A Brush arc lamp was connected to the circuit of an incandescent machine. The machine gave an E.M.F. of 100 volts, which was reduced to 50 volts by simply cutting one of the wires leading to the lamp and inserting two metal plates separated about one-fourth inch and submerged in a pail of water. The light was clear, white, and steady. The current taken by the arc lamp represents about 14 incandescent lights.

Cardiff.—The electric light is used in Cardiff perhaps more than in any similar provincial town. In the principal streets, the Opera House, the Music Hall, the Industrial Exhibition, in shops and arcades, at the docks, by the river side, and in the mines—almost everywhere electric lights, arc or incandescent, are now to be seen. At the Opera House the lighting is by an independent engine and dynamos, and the dockyards have their own installation. But a large number of public and private buildings are now supplied by the central station originally established by the Great Western Electric Light Company. Cardiff is one of our most go-ahead towns, and bids fair to become a principal seaport.

Apprenticeship.—We have received from Prof. S. P. Thompson two pamphlets, one containing his views in regard to apprenticeship as expressed some years ago, the other his views expressed quite recently. From these we gather that Prof. Thompson is still as warm an advocate as ever of the system of apprenticeship. We may also refer here to an excellent address of Prof. Perry in the same direction, also issued in pamphlet form. The views expressed both by Prof. S. P. Thompson and Prof. Perry in the direction of supplementing technical education by a modified apprenticeship are worthy of the most careful consideration, not only of parents, but of the youths themselves, whom future success in life is the text upon which these professors dwell.

Phonographic Morse Recorder.—Mr. R. J. Hewett, in the *Electrical World*, suggests the phonograph as a promising auxiliary to the Wheatstone automatic system. The phonograph can be substituted for the ink recorder, and the signals afterwards read off by a Morse operator at his leisure at lower speed. The phonograph motor would require two different speeds—a high speed for receiving the automatic telegraph signals, and a slow speed for reproducing to the Morse operator. The slow speed should still further be variable within a smaller range, so as to suit the ability of the receiver. Thus the automatic and manual service would be combined, the automatic being used for transmission, while the manual service, aided by the phonograph, can be employed for receiving.

Leamington.—It is understood that some modifications are to be made in the lighting at Leamington. Mr. Chamberlain will supply four arc lamps near the Town Hall, outputs to be agreed upon, and is willing to supply the current to these lamps and lend and fix the lamps on poles for £12, and for £18 to place 300-c.p. incandescent lamps on some of the existing lamp-posts, and to substitute 50-c.p. lamps for twenty-five of the existing 16-c.p. lamps for a further sum of £3. The total cost of these modifications would be about £43, but as Mr. Chamberlain will himself contribute one-third of this amount, the burden falling upon the ratepayers would be proportionably smaller. He will also gratuitously supply the extra current required during the month's trial. This without prejudice to the present contract.

Accumulator Trollies.—A new method of running accumulator cars, which may yet prove to be the manner in which accumulators will be used in traction, is being worked

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by Mr. Sandwell, of Victor Works, Holloway. In this system there is not a separate motor truck, as in the "electric locomotive" system, but the motor is on the tram-car, and the storage cells are carried in a small tender, built to match the car, and hooked on behind. The advantage of this method of carrying the cells is that no alteration is necessary in the structure of the tram-cars, and when changing the cells there is no trouble in lifting or pulling the cells out, but the trolly is simply disconnected and shunted away, while another one, ready charged, is hitched on behind. It will remain to be seen whether this method will prove as practical as the self-contained cars for tramway work, but it is fully evident that in some cases such a system would prove very useful.

Lampada.—The Italian technical paper *L'Elettricita* is publishing in parts, contemporaneously with its weekly issues, a dictionary of electricity and magnetism. A large number of types of incandescent lamps are treated under the heading "Lampada," and a great deal of very interesting details of experimental types of lamps by different inventors are given, many of them little known to the public, as will be understood when it is mentioned that there are thirty-four incandescent lamps by different inventors described, from André to Zanni. There seems to be, however, a strange want of due appreciation of relative importance in the compilation, for while lamps by Nothomb Rocco, and Cruto have full description, with tables or full-size cuts, the Swan lamp is briefly described in a few lines (with an half-inch cut), and with no indication that its importance is greater than that of a score of other names; while the Edison lamp, though with a fair illustration, is dismissed in three lines and a table of candle-powers.

Business.—Things are getting busy all round for the winter season. Existing electrical engineers are reporting themselves generally full of work, and the outlook for new enterprises is exceptionally good. Indeed, even now the demand for good men is active, and more places could be found for men really capable in both technical and business capabilities than there seems to be men to fill them. Our young engineers had better make up their minds what branch they intend to take up—lighting, traction, boats, motors, transmission of power, or what not—make themselves specially acquainted with what is now being done, and then let people know they are ready to do work. There will be plenty to do. Anyone who wants work, or wishes to engage in any particular branch, to better their position, or to engage in enterprise, had better send in their names to our register of addresses, with particulars of what they can do and what they require, that they may be at hand when anything is heard of requiring capable men.

Histon.—Messrs. Chivers and Sons' home-made jam works, established now for some years at Histon, near Cambridge, are extending their premises, which already employ over 100 hands, and have introduced the electric light. The installation has been carried out by Crompton and Co., Limited, and consists at present of fifty incandescent lamps and two arcs. Ten of the incandescents are of 50 c.p. and the remainder of 16 c.p. One of the arcs is used for unloading, and can be seen at night from the main line to Cambridge. The other arc is used at the confectionery pans. The dynamo gives 45 amperes and 110 volts at 1,700 revolutions, and is driven by a new engine, just put down for the works by Low and Duff, of Dundee—an 8-h.p. nominal compound tandem. The Histon home-made jam works are interesting economically, politically, and historically from the suggestion made by Mr. Gladstone about home-made jam production, and the continued success achieved, and the extension now found necessary, are proofs of the profitableness of the undertaking.

The Bloomington Contract.—The struggle for the right of introducing the electric light into Bloomington, Illinois, has partaken of the nature of a political election, and well illustrates the temper of the American citizen of the West. The Thomson-Houston Company installed a plant some years ago on the understanding that the municipality should have the option of purchasing it. The Fort Wayne Jenny Company obtained a footing in the town, and later made a bid for the city lighting, and the contract has been formally awarded to them. The struggle was of the most bitter character, says the *Western Electrician*, and the contest over the award enlisted the interest of the citizens generally. For weeks little else was discussed in the city. Charges and counter charges were made in the council, and the newspapers abounded in insinuations which reflected on the characters of persons directly and indirectly interested in the award. The excitement was so great, that when final action was taken 500 citizens gathered in and about the council chamber to learn the result.

Introducing Miners' Lamps.—Some experiments have recently been made at the Shireoaks Colliery with a view of introducing portable electric lamps into the mines. Mr. Oswald Swete, A.S.T.E., with his assistant, Mr. Smith, have been exhibiting the lamps of the New Portable Electric Lamp Syndicate. Mention of these lamps has lately been made in this journal, and the following details of cost are given: A one-unit dynamo, costing, say, £25, would charge 130 lamps in five hours, taking 1½ h.p., allowing for waste. The cost of lamp is £1, and 3d. per week per lamp is said to cover maintenance and repairs. One man and a boy are sufficient to look after 130 lamps. Trials have been made both above and below ground at Shireoaks, and Mr. John Jones, the underground manager, expresses satisfaction with the lamp, and is said to regard its introduction very favourably. A temporary laboratory was formed at the Shireoaks Inn, where the lamps were charged before taking down in the mine. A visit has also been paid to the Steetly and Southgate collieries, of the Shireoaks Colliery Company, and the lamps have also been exhibited to a large number of the miners themselves at Shireoaks Inn. Trials are also being made at the Weardale Coal and Iron Company's pits at Crosdale, Durham.

Tube-Iron Cars.—In any experiment with electric motors for heavy railway work, especially where accumulators are used, it will be well to keep in mind some recent development in wagon-building, described in the *American Journal of Railway Appliances* for this month. These consist in wagons with tube-iron frames built by the Iron Car Company of New York. The cars are constructed with framework of iron tubes braced and stretched in a mechanical way, and, with use of considerably less material than in an ordinary wooden car, much greater strength and durability is secured. In moving the Brighton Beach Hotel 112 of these cars were used. The load these cars had to stand was up to 100 tons, and under this severe test there was no mishap, although these were ordinary cars not specially built for the occasion. The severe tests to which these iron cars have been subjected in actual service show that while they are from 2,000 to 5,000lbs. lighter than wood carriages

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of similar size, they have an elasticity and strength that is unapproached by wood cars. Some of these cars have recently been tried at St. Pancras. The English goods truck weighs five tons and carries eight; the American, which weighs eight or ten, carries 30 tons. The total saving in dead weight is practically that of half the old cars.

Transmission of Power in France.—The town of Bourganeuf, Creuse, will shortly have running a central station for supply of electric light and of power. The work is in course of construction by the Société pour la Transmission de la Force par l'Electricité, and it is expected that the station will be open by 1st November. The motive power is obtained from the falls of Jarreaux, distance eight or nine miles from Bourganeuf, estimated to give 1,000 to 1,200 h.p. The power will be obtained by turbines, the first of which, supplied by the Société Alsacienne Mechanique, is already fixed and will supply 700 incandescent lamps to the town, and 30 h.p. for various ndustries. A local lighting company has already for two years undertaken the lighting of the town, but had unfortunately taken its power for 250 lamps from a stream which dried up in the summer, and has been unable to fulfil its contracts, but by the use of transmission plant the whole of the town can be supplied. A second turbine will be placed lower down, and four others will be added as the demand increases in the district, where there are numerous industries requiring power. The current will be supplied by Marcel Deprez dynamos: one generator, with one receiver, and two lighting dynamos will be fixed at once.

Electric Charging Stations.—Charging stations for the supply of electricity to electric launches are being established up the Thames by Messrs. Immisch, under the superintendence of Mr. Magnus Volk. Two permanent stations are in progress, besides one floating station, and doubtless others will be added. This prospect will probably cause numbers of boat-builders to take up the question of electric pleasure launches for the beautiful reaches of the upper Thames, in addition to the one or two specimen boats run by the inventors already notorious at swell regattas. These launches have hitherto all been small, but a more ambitious venture has been made this week in the launching at Chiswick of a large electrical pleasure boat owned by Messrs. Immisch and Co., and we shall probably hear of makers of steam river launches introducing this new method of propulsion in their new boats on account of its cleanliness and silence, now that the possibility of obtaining power at reasonable distances seems within reach. We still adhere to our idea that many of the large riverside hotels will eventually find it to their own and their clients' advantage to establish charging stations in connection with their hotels, and supply not only bed, meat, and drink, but energy itself to the pleasure-seekers up the river.

Central Station in the City.—At last the busiest portion of the busiest city in the world is to have a central incandescent light station. We are not ignoring the Deptford station, which is to supply the city on a high-tension system; but up to the present, although many banks and offices have had their own installations, there has been no attempt at central distribution of electric light in the City itself. Messrs. Crompton and Co., Limited, have now decided to establish a central station for the supply of current for incandescent lamps near the Stock Exchange, and a site has practically been decided upon. The scheme is very well received, and already over 1,000 lights have been subscribed for within two or three days. The terms will be: For the supply of the electric light switched on from central station at 9 a.m. each day (public holidays excepted) and switched off at 8 p.m., a fixed charge of 30s. per lamp per annum, 10 c.p.; for underground premises, or where the light is required all night, the charge will be by meter at 8d. per Board of Trade unit, or at a fixed rate, if preferred, of 50s. per lamp per annum. The installation will be on the battery-transformer system, with storage capacity for a large proportion of the lights, and the plant will be almost an exact duplicate of that which has been so successfully established by Messrs. Crompton's at Kensington Court.

Electric Pleasure Boats.—The "Viscountess Barry," the first public pleasure boat to be driven by electrical power on the river Thames was launched this week at Chiswick. This boat has been built by Messrs. Immisch and Co., and will be worked in connection with their charging stations. It is 65½ft. long, 10ft. beam, and designed to carry 80 passengers, with a mean draught of 22in., 12½ tons displacement, at six miles an hour, as regulated by the Conservancy bye-law. The electrical machinery and storage cells being placed below the deck fore and aft, leaves a clear run the whole length of the boat for passengers. In the middle is a handsomely-fitted cabin with lavatories, dining-table, &c. The accumulators are 200 of the Electric Power Storage Company's heavy "traction" type, and two Immisch motors of 7½ h.p. each drive two twin three-bladed propellers, by Thornycroft and Co. The hull is designed with primary view to comfort of passengers, and is constructed of bright mahogany and teak throughout. This is only the first of a series intended for the Thames, others being now laid down. Reports appearing in the daily papers have made it appear that this electrical boat was built for and by Mr. W. Sargeant. This was based on a misapprehension. Mr. Sargeant, we understand, was originally employed by Messrs. Immisch in connection with the undertaking, and has now established himself as electrical launch builder on his own account at Chiswick. The boat is the property of Messrs. Immisch and Co.

Electric Tramways.—The editor of *Truth* having asked why our electricians cannot give us electric traction, which is already so largely introduced in the United States, has received several letters from electric engineers and others interested in this question. He says: "The chairman of the Birmingham Central Tramway, who has obtained the control of the Julien patents, which are being worked on the Brussels tramway, is sanguine of being able to successfully introduce this system in this country, although certain improvements will first have to be made. Mr. Thomas Fraser, the engineer of the Electric Traction Company, writes that he is building half a dozen electrical tramcars for the equipment of the North Metropolitan Tramway Company's Canning Town line, one of which is already completed. We have also received a communication from the Series Electrical Traction Syndicate, Limited, of 11, Queen Victoria-street, according to which the construction of a line near London on their system (to which Prof. Ayrton called attention at the recent meeting of the British Association) has already been commenced. This line will probably be opened for traffic in the early part of December. Messrs. Woodhouse and Rawson, the well-known electrical engineers, also inform us that they are prepared to take con-

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tracts for running tramcars by electricity at a considerably less price than by horses. It is to be hoped that the tramway directors will be enterprising enough to avail themselves of this means of considerably affecting their companies' dividends, and, in fact, of giving many of them a fresh lease of life."

New Technical Institutes.—A large scheme for providing four new technical and recreative institutes for the north of London is being organised, to provide for the wants of the million or so of people in the boroughs of Finsbury, Hackney, Islington, and St. Pancras. These will aim to continue the education of young people after leaving school from thirteen to eighteen years of age, and to provide technical classes of all sorts to direct their energies into useful quarters. The sum of £400,000 for the four institutions in all will be required. The scheme has been well taken up by a numerous and influential committee, for whom Sir Charles Russell Q.C., and Sir Julian Goldsmid are treasurers. The Charity Commissioners have agreed to give £200,000 from the funds of the City Parochial Charities entrusted to their charge if a like sum is raised by the four boroughs. The powers of the Commissioners are temporary, and will expire on December 31, 1889, and to avail themselves of this magnificent offer the boroughs must not only raise the money, but the schemes must be prepared and finally approved before that date. The four institutions are to be on the general lines of the Polytechnic in Regent street, which provides not only technical and general secondary instruction, but has large provision for physical and recreative training. The North London institutions are of course to be open to all, though to be placed specially to meet the wants of the districts named. Communications to be addressed either to the Chairman of the Provisional Central Executive Committee, J. H. Allen, Esq., J.P., 2, Chester-terrace, Regent's Park, N.W.; or to the Secretary, at the temporary offices, 20, Finsbury-pavement, E.C.

Asbestos Catalogue.—We have received the handsomely-printed catalogue of the Bell's Asbestos Company, Limited, Southwark-street, London, setting forth and illustrating the numerous applications of their manufactures of asbestos. It is, indeed, astonishing to note the wide field now covered, and the uses, in all directions, which have been found for asbestos by the energy and enterprise of the Bell's Asbestos Company. Besides the several kinds of asbestos packing, now well known to the trade over the whole world, compounded with chalk, soapstone, vulcanised rubber, or metallic wire, according to the uses for which it is put, we note many applications of asbestos sheeting, of yarn, of paper, and of millboard, asbestos cloth and asbestos fibre for use with chemicals, asbestos cordage for fire-escape ladders, and for hot-air pipe joints, asbestos flooring and wall felt, and asbestos paint, cement, and putty. One very important application to which Messrs. Davey, Paxman and Co. give their testimonial is that of asbestos non-conducting boiler composition, which they used for their boilers at the exhibition at South Kensington; the temperature, with a pressure of 120lb. on the inside bare plate, being, before covering, 265deg., after covering was not more than 91deg., a result with which they are highly satisfied. A method of combining asbestos covering with hair felt has been introduced for covering steam-pipes, and has proved most simple, convenient, and economical, and is, moreover, easily adapted to sharp elbows and curves. Bell's asbestoline, a special lubricant introduced by this company, seems to have given a great deal of satisfaction for use in quick-moving machinery in the place of oil, and a pound of the asbestoline is said to equal in effect two gallons of oil weighing 18lb. It contains no mineral oil, and does not give off inflammable vapour under 400deg., nor can it be set on fire by application of flame. We notice that the Gulcher Company have given a testimonial for the use of asbestoline as a lubricant for heavy shafting transmitting 130 h.p. Several other special applications are illustrated, and altogether the catalogue will prove of great usefulness to electrical engineers, both in the electrical and the engineering departments. The telegraphic code appended to the catalogue will make it more convenient to wire quickly and inexpensively to "Belfry London," for asbestos articles of all sorts and sizes.

Swansea.—A very important meeting of the Gas Committee of the Swansea Corporation was held on Tuesday afternoon for the purpose of considering what steps should be taken in the interests of the ratepayers consequent on the action of the Swansea Gas Company in deciding to increase the price of gas supplied to both the corporation for public purposes and to private consumers. There was a large attendance, and considerable interest was manifested in the proceedings. The town clerk had obtained counsel's opinion upon the question of the corporation erecting their own gas works, and, in addition, he submitted a report on other modes of lighting the borough. It appears that since the increase in the price of gas, very energetic steps have been taken by the Corporation Commitee with the object of seeing if some other means of street and public lighting may not be adopted. There is expended on the lighting of public buildings and the streets about £4,000 per annum, and there is a strong feeling that the corporation should show that it can afford to be quite independent of the gas company. The recent increase in the price of gas has caused the question of lighting by other means to be raised, and statistics were produced showing the relative cost of lighting the town by means of gas, electricity, and oil. The cost of the two first-named luminants would be about the same, but offers to supply equal illuminating power by means of oil were forthcoming for about half the money. The town clerk's report on the question of electric lighting was most elaborate. After quoting a great number of facts, he pointed out that their general effect was that there were three means whereby authority can be obtained to light a town by electricity, viz.: 1. By special Act. 2. By license. 3. By provisional order. He did not think it was necessary to go into the first of these, as the general experience was that it was cheaper and more expeditious to obtain either a license or a provisional order. By means either of a license or a provisisional order the local authority might obtain power to themselves to light with electricity (1) for public purposes, (2) for private purposes, (3) for both; or they might grant permission to a company to apply either for a provisional order or a license, and such company would have generally the same powers of lighting as the local authority themselves would have if they had obtained a license or a provisional order for themselves. In the discussion which followed the statement of the town clerk, it was pointed out that it would not be necessary to obtain any parliamentary sanction to light the town with oil. Eventually it was decided to recommend the council to at once apply for a provisional order to light the town by means of electricity.

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LEAVES FROM THE DIARY OF A YOUNG ELECTRICIAN.

BY BROAD BENT.

(Continued from page 283.)

September 14.—I was called down to C. S. station about three o'clock to attend to three lights. "They went out all of a sudden," I was told. This appears to be a favourite expression here; I am generally informed that a light was all right at such a time, "and then, all of a sudden, it went out." This, then, was clear, that if the three lights went out all at the same moment, being the only three on that circuit, one cause was common to them all. There was a double-pole fuse in the circuit, which was the first thing I looked at. One of them I found to be melted. On replacing this with a new one, the lamps appeared to light up for a moment, then there was a flash and a splutter in the region of the fuse—this also had melted. That means there was a "short circuit" somewhere; the question was, "Where?"

It was an easy matter to see where it was not, as the conducting wires which ran along the roof of a staircase were not cased in, but simply fixed up by cleats. The lamps were suspended by twin wires from ceiling roses, which had metal covers—twin wires on a 160-volt circuit, and in a damp place, too! The natural conclusion I came to was that the short circuit was either in the twin wires or in one of the ceiling roses, so I commenced taking off the metal covers of the latter, after having connected a lamp between the terminals of the melted safety fuse. This I did that I might see when the short circuit was eliminated. Whilst removing the second cover the three lamps reddened up, the test lamp going down. The latter had, of course, been burning bright previously.

The cause of the "short" was this: Just where they passed through the hole of the cover one of the wires had become bare, thus making metallic contact with the cover. In addition to this, a screw in connection with the other wire made contact with the inside of the cover, thus completing the circuit. This was soon remedied by cutting off the bare wire, filing down the head of the screw, and inserting a small tube of wood in the hole of the cover to prevent the wires becoming chafed again.

September 21.—There are more failures due to bad contacts than to any other cause. Almost every day we are called to attend to lamps whose extinction is owing either to loose or dirty contact between the hooks of the holders and the loops of the lamps, or to imperfect connection in the safety plug. I have just put three lights right by simply screwing up the safety plug. Very often, instead of going qut entirely, lights burn very dull from this cause, and I have known the woodwork of safety junctions to char, and in some cases to catch fire, presumably owing to the heat generated consequent upon the high resistance introduced by dirty connections. Only a few moments ago the insulation of a wire here in the shed caught fire, and on examination I found that it was caused by a loose twisted joint becoming red hot. The wires were No. 16 B.W.G., and were carrying less than two amperes.

October 4.—The dull season has commenced. The steam and smoke hang about the station like a thick fog, making everything very damp; water is constantly dropping from the ceiling on to our cables and wires. Frequently it is necessary to use both gas and electric light, and occasionally it is impossible to see either when standing within a few feet of the lamps.

October 8.—This damp weather has begun its destructive work upon our wires and fittings. I have just come in from O.R., where one of the overhead cables has broken and dropped across the platform; it will be a nice little job repairing that to-night, after the traffic has ceased. The cable is composed of 19 strands of about 18 B.W.G., so it will be no easy matter for one man to hold and splice at the same time. There must have been some water dropping on it, as it seems fairly rotten. I shall have to put about 2ft. of new cable in, which means making two joints. Hang the cable, I say.

October 9.—We repaired the broken cable at O.R. last night—more correctly, this morning, as it was between one o'clock and five—but we had an unlooked-for, and at the same time unpleasant, experience by way of preface. When we had almost reached the station, but whilst still in the tunnel, with no other light but that from our lamp, no one else stirring but ourselves—the engine-driver and I—we heard the most unearthly, agonising howl that I ever had the misfortune to hear. For a moment we both stood rooted to the spot. W———l is a lively place at the best, but surely there could be no one in the station at this time of the morning. All sorts of thoughts were rushing through my brain, when the cry was repeated.

Evidently someone was in pain, so it was our duty to ascertain where he was and help him. We found, eventually, that some poor man, in endeavouring to find a night's lodging in an empty building, had fallen over the station wall, dropping a distance of about 30ft. on to the concrete floor of the platform. Electrical matters had to be abandoned for the moment and a little impromptu surgery performed. As all the station doors were locked it was some time before we could get help from outside, and it was about half past two before the man was finally removed to the hospital by two members of the much-maligned metropolitan police force. I heartily wished he had chosen some night for half-killing himself when I had no cables to repair. However, it was fortunate for him that the cable was broken, or he would have lain there for about five hours.

Repairing the cable was, as I anticipated, no easy matter. It was first necessary to bring the two broken ends as near together as possible, and hold them in position until the joints were spliced and soldered, which would not have presented any great difficulty had it been possible for two men to get at it at the same time. Unfortunately, it was not. I therefore fastened the two ends of a stout wire to the broken ends of the cable, so that by twisting the wire I was able to bring the ends up to the required position. Having made the joints in the neatest and most satisfactory way I know of, the job was to solder them. A soldering iron is not much use for a joint of any size, for unless it is itself too heavy to handle comfortably it will not retain its heat for a sufficient length of time. An auto-blowlamp, therefore, had to suffice. A blowlamp is very useful when there are no miniature cyclones hovering around; but if, just as the solder is beginning to "run," a gust of wind blows the flame into one's face, and cools the joint down again, one is apt to say, or do, something rash. I know *I* did last night. However, with patience and perseverance I made a job of it at last. The question naturally arises, "What was the cause of the cable breaking?" It was this: I found that there had been a joint at this same place before, which, from all appearances, had been simply covered with a few layers of binding tape. In a very dry place, that sort of covering might be sufficient, although I should never trust to it myself; but in a damp atmosphere like that of a subterranean railway it is very little better than nothing at all. The tape having become saturated with the condensed steam from the locomotives, and impregnated with the sulphurous fumes, &c., electrolytic action set in, causing the copper to become deposited upon the solder until the wires had become reduced in thickness to such an extent that they could no longer support the weight of the cable. *Moral:* Cover a joint so carefully that its insulation resistance shall be at least equal to that of any other part of the conductor under similar conditions. What I have found to be a fairly satisfactory method (except on the bridge at S.M. station) is this: As soon as the solder is thoroughly sweated in, smear the joint all over with a layer of "chat";* then bind two or three layers of indiarubber or guttapercha tape around it, and cover that with a few layers of good insulating tape. Then warm the whole affair by holding a spirit lamp underneath it, and squeeze it well with the hands, so that the chat will be forced into all the crevices.

October 27.—Another switch failure to-day; this time at H.P. station, where many of the lights are not required in the day time. A plug switch is provided on the platform to cut out 17 lamps; 10 on another circuit being always alight. It is a similar case to that which occurred at M.A. some time ago; the lights do not go out on removing the

* Chatterton's compound.

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plug. The day man has spent half the day in a fruitless attempt to discover the cause of failure, so I must have a turn at it after we shut down to-night.

October 28.—Spent all last night in trying to find out why the lights at H.P. would not go out, but without success; at least I knew the cause, but failed to localise it. The facts are these: On the platforms there are two circuits, one of 10 lights and one of 17. Through the former, the current is always flowing (that is, whilst the machines are running). The latter circuit is only used from four to ten hours a day, depending upon the time of the year. Now these circuits are bound together—a most absurd idea—with tape for a distance of about 100 yards. It is within the bounds of possibility that the two circuits have united somewhere beneath this mass of tape. However, I removed it from about 80 yards of the cables last night without finding any connection. The portion that runs across the line from one platform to the other I did not examine, for want of time. To do this, and to remove the cables from all the insulators, would be a work of days. It stands to reason that if two distinct circuits from a comparatively high potential source are bound together over a track along which a steam locomotive passes at least every two minutes, they would become damp; so that one circuit would always form a shunt of unknown resistance to the other circuit; the resistance depending upon the dampness and composition of the covering, &c. Hence, whether the lights of the one circuit are out or in, power is wasted over it, and eventually the insulation gives way at the weakest point, and the two circuits become amalgamated, so to speak. But I am wandering from the facts. Not having sufficient time (or inclination either) to take down all the cables and put them up again, I devised a labour-saving dodge. The switch consists simply of a rectangular slab with four terminals, *a*, *b*, *c*, and *d*, fixed upon it. The current is led from the main to the two bottom terminals, *c*, *d*; the 17-light circuit being taken from the top terminals, *a*, *b*. On the right hand side, the terminals *b*, *d* are joined by a lead safety fuse, whilst those on the left, *a*, *c*, are so constructed that a brass plug may be inserted between them. When this plug was removed, the lights ought to have gone out, but they didn't. I found, however, that this was accomplished by disconnecting the safety fuse. (I am glad no one will ever see this.) I simply turned the whole affair upside down, so that the plug took the place of the safety fuse and *vice versâ*.

Of course, that safety fuse is no good now; I must put one on the plug side.

(*To be concluded.*)

ALUMINIUM AND ALUMINIUM ALLOYS.*

The special properties which aluminium confers on metals like copper, iron, &c., when used as an alloy, have attracted for some time past the attention of metallurgists, and we may expect in the future great developments in this field. Until recently the expense of producing these alloys in large quantities has been practically prohibitive.

The Swiss Metallurgical Society in Lauffen-Neuhausen, Canton Schaffhausen, has, however, succeeded in producing aluminium alloys in large quantities by means of Hérault's patent method. This consists principally of a method of employment of the electric current for fusing the refractory earths containing aluminium. The negative electrode is composed of the metal—copper, iron, or tin—with which it is desired to alloy the aluminium; the positive electrode is composed of a group of carbons dipping into the molten argillaceous earth. The current is generated by means of a vertical 300-h.p. Jonval turbine, Figs. 4 and 5, driving two dynamos of 6,000 amperes and 20 volts each, which are excited by a 300-amperes Erreger dynamo. The turbine has been specially made for this purpose by Messrs. Escher, Wyss and Co., of Zurich.

The current which this process required has entailed the construction of special dynamos, the main problem in which was to generate a sufficiently large current. Dynamos for so abnormal a current had not been constructed, and may be regarded as among the biggest engines that have ever been built on the Continent. The construction of these giant machines (Figs. 1, 2, 3, and 5) was undertaken by the Oerlikon Engine Works, and Mr. C. E. L. Brown's system of construction, in which the armature wire is wound through holes in the shaft of the armature, was found especially suitable. The machine has six field-magnets, and so consists of a single casting of 10,000 kilogrammes in weight. The field-magnets are excited by means of a special machine. The armature has two separate windings, each of which has six parallel divisions. The two principal windings are also partitioned off separately. Each machine has two large collectors, and no less than seventy-two brushes. Copper cables of the thickness of a man's arm conduct the electric current from the machines to the oven. The current from

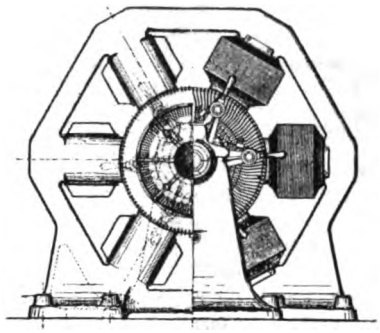

FIG. 1.—120-Kilo Watt Dynamo, Oerlikon Works, Zurich. System C. E. L. Brown. (Elevation and Cross Section. 6,000 Amperes, 16 to 20 Volts, 180 Revolutions.)

both dynamos is passed to the positive electrode in the furnace, D, Figs. 6 and 7. The smelting takes place in a carbon crucible, A, Figs. 6 and 7. This is surrounded by a metallic covering connected with the negative cable, and serves as a receptacle for the molten oxides and metals, and also as a conductor, inasmuch as it forms part of the circuit.

The positive pole of the apparatus is formed by a group of carbons, B, made of carbon plates, *b*, while the negative pole consists of molten metal at the bottom of the carbon crucible, A; the floor of this crucible has an escape closed by the carbon rod, C. In Figs. 6 and 7 the general arrangement of the apparatus is represented, the longitudinal section being given in Fig. 6; and in Fig. 7 the plan is given with a horizontal section of the group of carbons.

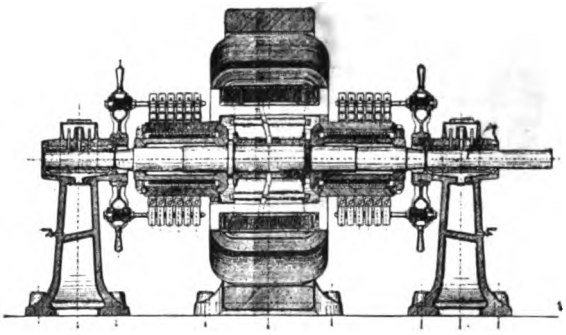

FIG. 2.—120-Kilo. Watt Dynamo, Oerlikon Works, Zurich. System C. E. L. Brown. (Longitudinal Section. 6,000 Amperes, 16 to 20 Volts, 180 Revolutions.)

On the floor is a box, *a*, of iron or other metal, insulated at the bottom and open at top; this is fitted with a lining of carbon plates, which are then cemented together with either tar, sugar, syrup, or fruit syrup. The box, *a*, which surrounds and secures the basin, A, forms an excellent conductor. In the box, *a*, are a number of copper pins a^1, which conduct the negative current. The positive electrode plates, *b*, are placed separately one over the other. These carbon plates may be so arranged as to have spaces between them which can be filled in with a good conductor like copper or soft carbon. The upper ends of the carbon plates, *b*, are connected by the cap, *g*, the loop, *e*, of which serves as a link to a chain, by means of which the carbon bundle is brought into position, and can be raised or lowered as desired. The frame, *h*, surrounding the carbon bundle is provided with the necessary fastening appliances,

* Translated from the *Schweizerische Bauzeitung*.

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such as binding screws, &c., for the attachment of the + cable.

With the exception of the space, *i*, necessary for the play and the vertical motion of the carbon bundle, the opening of the basin, B, is covered by graphite plates, *k*, which have a few openings, *n*, for the introduction of materials. Corresponding to the openings, *n*, grooves, *m*, are necessarily made in the side walls of the basin. These channels, *m n*, also serves as an escape for the gases generated in the basin. The movable plates, *o*, provided with handles, o^2, serve as coverings to the openings, *n*, during certain phases of the smelting process. The space, k^1, between the graphite

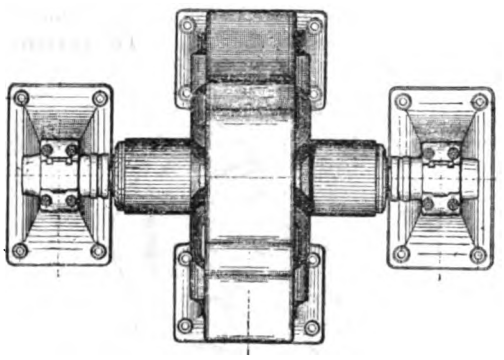

FIG. 3.—120-Kilo. Watt Dynamo, Oerlikon Works, Zurich. System C. E. L. Brown. (Plan. 6,000 Amperes, 16 to 20 Volts, 180 Revolutions.)

plate, *k*, and the rim of the box, *a*, is fitted with charcoal powder.

The process is commenced by placing copper broken up in small pieces into the bottom of the crucible, A; the carbon bundle, B, is hereupon brought nearly into contact with the copper; the current goes through the copper and

The carbon bundle must, as stated before, be raised or lowered according to the resistance. But this can be automatically regulated by means of the chain supporting the bundle, B, which can be put into communication with a reversible dynamo-electric motor—regulated by the ampere meter—which acts as an electrical regulator. To let off the collected fluid aluminium bronzes, the ingot mould, *l*, is

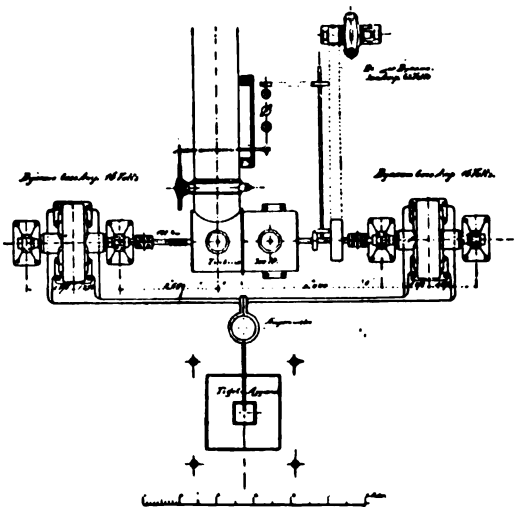

FIG. 4.—Plan of the Works of the Swiss Metallurgical Society at Lauffen-Neuhausen.

placed under the tap-hole, *c* C, and the channel, *c*, opened by removal of the carbon bolt. The least current has been found to be one of about 12,000 to 13,000 amperes, and of about 12 to 15 volts.

This process admits of the production of all forms of aluminium alloys, always excepting such metals as evapo-

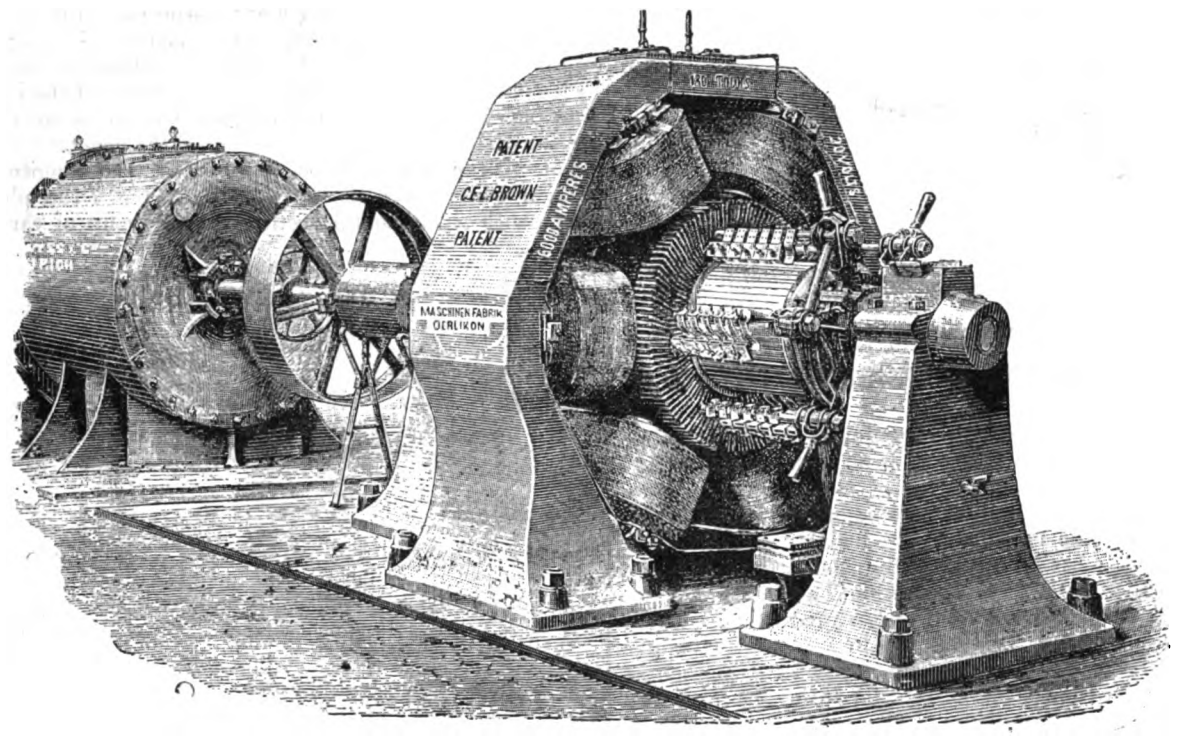

FIG. 5.—Electro-metallurgical Plant, Lauffen-Neuhausen.—Perspective View.

melts it. As soon as the bath of fluid copper, which serves as the negative pole, is ready, argillaceous earth, $Al^2 O^3$, is put into the basin, and the bundle, B, is lifted a little higher. Now the current will pass through the argillaceous earth, which melts and decomposes. The oxygen attacks the carbon, *b b b*, and breaks it up, so that carbonic oxide gas escapes from the basin; the aluminium dissociates from its oxygen combination and flies to the copper, so that direct aluminium bronzes are formed. The basin is now fed according to the progress of the smelting with copper and argillaceous earth.

rate at the melting point of aluminium; in such cases, however, they can be replaced by copper. Directly-mixed combinations can also be effected, as, for instance, a combination of copper with silicium and aluminium by the use of silicate of alumina instead of argillaceous earth.

With the installations of the Swiss Metallurgical Society it is possible to produce daily 300 kilogrammes of aluminium, or 3,000 kilogrammes of 10 per cent. aluminium bronze. Production is continuous, as the furnace can be worked for months day and night, and can be either entirely or partially emptied by means of the tap-hole. Below are some

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results of some experiments made by Prof. Tetmajer, at the Polytechnic of Zurich, with aluminium obtained from the furnace.

The brass used in the experiments is an aluminium bronze; and brasses were cast, and had not undergone any further manufacturing process beyond being turned. These aluminium copper alloys need not, however, be cast; they can be as easily hammered, rolled, or drawn.

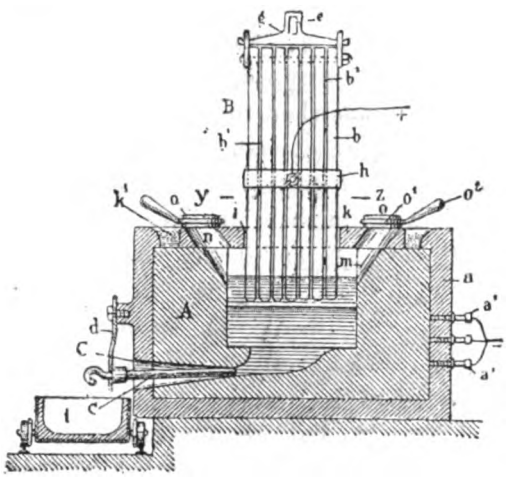


FIG. 6.—Vertical Section of Electrical Aluminium Furnace.

Aluminium brass and ferro-aluminium are two very remarkable aluminium compounds. The former is distinguished for its hardness and tensile strength; the latter, if added in small quantities to steel, insures this a clear and limpid casting. The production of ferro-aluminium is similar to that of the bronzes, inasmuch as the iron takes the place of the copper.

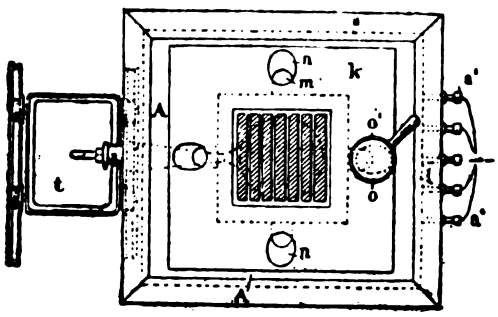


FIG. 7.—Horizontal Section of Electric Furnace.

On July 30th the inauguration of this installation took place in the presence of the shareholders and directors. It worked very satisfactorily. Although designed for 12,000 amperes, the dynamos could yield 25,000 amperes without any interruption.

Metal.	Tensile strength Kg. per mm.²	Extension. Per cent.
Aluminium bronze A	34·6	25·4
,, B	38·4	27·4
,, C	36·4	34·3
,, D	48·	37·5
,, E	51·6	39·2
,, F	56·	23·
,, G	62·1	18·5
,, H	64·	7·
Aluminium brass	48·1	20·7
Steel for artillery tubes	55·	14·
*Bar iron	38·	22·
*Delta metal	38·	20·
*Industrial bronze	23·	8·0
*Phosphor bronze	29·	17·
*Manganese bronze	29·	17·
*Durana metal	36·	22·

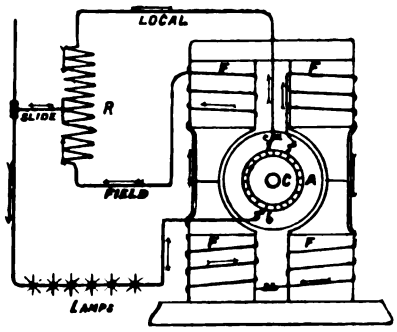
* Verified by Prof. Tetmajer.

TEMPERING DRILL POINTS.—The following note may be useful to engineers, electrical or otherwise. A workman in the Carson Mint is said to have made the discovery that drill points may be so tempered that they will penetrate the hardest steel or plate glass by heating them to a cherry red, and then driving them into a bar of lead.

THE WATERHOUSE REGULATOR.

The accompanying diagram shows the method adopted by the Waterhouse Company for regulating their new dynamo. A shows the closed circuit armature, the commutator, C, having on it three brushes, *a*, *b*, *c*, the two former being the main brushes, the latter an auxiliary. The current from *a* goes round the field-magnets to the resistance, R, while the current from the auxiliary brush goes direct to the resistance. Here these currents reinforce each other, and the whole current goes to the lamp circuit through the slide. Varying the position of the slide means putting more resistance into the field-circuit, or into the auxiliary circuit, as the case may be. The slide, or regulator, is controlled by a solenoid.

The action is as follows: The brushes are fixed, but as the resistance in the circuit varies, the line of commutation varies. If lamps are turned off, the line of commutation moves from *a* towards *c*, more current going through *c* and less through *a*, thus reducing the current in the field-magnet coils, the magnetic field, and the motor-power required to drive the armature. The greater current going direct through *c* compensates this, and the current through the lamps is practically constant. The regulator represented in the diagram by the slide assists in making the regulation instantaneous.



The Waterhouse Regulator.

The solenoid is so arranged that an increase in the current through the field-magnet raises the slide or armature, thus throwing more resistance into that circuit and lessening the resistance in the local circuit. A decrease of current acts in a contrary manner. The Waterhouse regulator varies the electromotive force directly as the resistance of the outside circuit, maintaining the standard current on the lamp line by balancing the field circuit and the outside circuit.

CORRESPONDENCE.

ELECTRICALLY REFINED SUGAR.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—A good deal of the criticism to which the American experiments have been subjected seems to be based on the assumption that the process is an electrolytic one. I am not disposed to think that electricity is likely to be so employed, for the reason that a very large percentage of the saccharose would probably be transformed into dextrose and lœvulose. If sugar is refined by electricity, I do not think this agency will be employed to produce oxidation—in fact, I am inclined to think that its liability to produce oxidation will prove the greatest drawback to its use.

In your last week's issue you draw the inference that because electrolysis is successful in the purification of sewage, it may also be successful in the sugar refining; but the two cases are entirely different. In the former case, oxidation is just what we want to produce, whilst in the case of sugar refining—except, perhaps, for a secondary purpose—it must be avoided.—Yours, &c.,

J. G. LORRAIN.

Norfolk House, Norfolk-street, Strand, W.C.,
October 10, 1888.

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Letters await Terminals and E. E.

NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

LIGHTING THE CITY.

The action of the Brush Company reminds us of the French soldier before Sebastopol. The tale runs that a French and an English soldier, after fraternising one day, had a difference of opinion, which could only be settled in one way. There were plenty of friends around willing to see the fun and assist the combatants with advice. At any rate a ring was formed, and the men stripped, the Frenchman being duly admonished that when he was satisfied he was to cry out "Enough! enough!" The fight began, and the Englishman quickly proceeded to make it warm for his antagonist, who, after a few rounds, was perfectly satisfied and badly wanted to stop; but, unluckily, in the excitement of the moment he had forgotten the catchword. The spectators kept on hallooing "Hurrah! hurrah!" and Johnny thought this was the word he wanted, so he, too, yelled "Hurrah, hurrah!" but his foe only pummelled him the harder, so, in sheer desperation, he went on again hammer and tongs till the Englishman cried out "Enough! enough!" and caved in. "That's what I've been trying to say the last half-hour," said the Frenchman when victory rested in his favour. Naturally, one would have thought the Brush Company had had enough of the Corporation of London; but no, they come up again to the attack and with such determination that it needs no prophet to foretell that ultimately they must achieve a redoubtable victory. It has for some time been known that negotiations between the company and the Corporation have been reopened, and a pamphlet, marked "for private circulation only," has been distributed by the company among those interested in the subject, giving a succinct history of past negotiations for electrically lighting the City. We do not know that any new reasons can be put forward to induce the City fathers to adopt electric lighting. Almost everything that could be urged has been urged, and yet the first city of the world has rested content with the cry, "as you were." Progress has been made, but not with the aid of the City of London. The spirit that seems to guide many of our corporate bodies is rather that usually attributed to hucksterers than that of enterprising business men, tinged, it may be, with rather more than a mere *soupçon* of speculation. We will venture, notwithstanding the word private, to refer to the history of the case as given in the pamphlet. As long ago as 1880 the germ of a desire to light the streets existed, and the question was referred to the Streets' Committee. The time was subsequent to the Paris International Exhibition in 1878, when Jablochkoff lighted some streets in Paris, and at a time when great expectations were held as to the progress that was to be shown at the Paris Exhibition of 1881. Contracts were entered into with three companies—the Brush Company, Messrs. Siemens Bros., and the

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Jablochkoff Company. Under this contract, and renewals, the Brush Company supplied electric light to No. 1 district for five years (1881 to 1885 inclusive) on an average about 11 hours per day. At the end of this period the conductors, which originally had been laid with no view to permanent lighting, had deteriorated so as to cause occasional failure, and the company obtained permission to suspend the lighting in December, 1885. From that time till the present the question of a new contract has been more or less under consideration. At times everything seemed favourable to an agreement, when opposition from unexpected or interested quarters led to further delay. Just lately the argument of more light and less police has been put forward. It should preferably be more light and more police; but while the question of police is of the greatest importance to the preservation of life and property, the question of light refers more especially to the getting of property—that is, it aids business and by so doing helps profits. It seems to us that the information as to the amount of work done and less liability to be away from business, given by Mr. W. H. Preece, F.R.S., as the actual result of the experience of the Post Office authorities is so overwhelmingly strong and so impossible to be controverted, that any business man who could possibly adopt the system should not hesitate a moment. Too great importance cannot be given to such a statement as that of Mr. Preece, at Bath. The saving in salaries due to less absentees from illness amounts to £640 a year. The total cost of the electric light, including interest on initial cost, comes to £1,034 a year, as against £700 for gas, and yet the balance of saving is in favour of the electric light by £266 a year. The same gentleman has, in other addresses, remarked upon the quantity and quality of the work performed under the electric light compared with that obtained under gas. These things are facts, stubborn facts, and yet the great centre of the world's business is permitted by the supineness of its governing body to continue its work under the less valuable artificial light. On the one hand, we have the facts above given, founded upon experience. The opponents of the system are either interested in other systems or are absolutely in ignorance of the comparative values of the rival systems. Arguments deduced from America are more or less valueless. Prof. Ayrton summed up the idiosyncrasies of the average American and the average Englishman in the epigrammatic definitions he gave as applying to "inertia" there and here, the one was "opposition to stoppage," the other was "opposition to motion.' If "business" was the sole object of life and sleep not a necessity, surely everyone would prefer noontide light during the whole of the twenty-four hours; but as this is an impossibility, surely the nearest equivalent we can get to daylight is the best light we can obtain for business purposes. Electrical engineers should appeal to the pockets of their possible customers, and not to sentimentalism or philanthropy. How quickly electricity has been adopted on board ships. Why? Not because it was compared lamp for lamp with oil or candles, but because, on the whole, it was easily seen to be cheaper and far better than either. The gas interests may fight to the bitter end, and may delay the introduction of electricity, but in the long run it must come, both in the shape of light and in the shape of power.

Gas may be used for heating purposes, but it will be well to say that the rhodomontade talked about electricity not hurting gas is pure fiction. The fight has got to come, and the gloves may as well be taken off at once. Our "client" is electricity, and it has no common bond of union with gas. The latter at the best is a miserably noxious and poisonous and explosive material; it has nothing but convenience to recommend it. The sooner we get rid of it as a light the sooner will our houses be sanitarily better in all respects, get rid of it in our warehouses and our workshops, and more and better work will be done by the workpeople. The assistance that would be rendered to a freer distribution of electricity by its adoption for lighting the City streets would be enormous. And failing this assistance, many users are obtaining it at a slightly enhanced cost on their own account. The best-known banks have adopted it, so have some of the larger insurance companies, and other large business houses. The latest news is that a central station, carried out by Messrs. Crompton and Co., is to be started in the heart of the City. At Whitehall, at the Grosvenor Gallery, at Kensington, in Oxford-street, in Cadogan-square, centra stations are in operation, or about to be put into operation. The American, with his intense hatred of standing still, would have long ago had in operation a broad and comprehensive scheme for lighting the town, and preventing overlapping between the various companies. Now the better positions will be gradually filled up and the slums left to themselves. Of course a few robberies and murders will bring a howl of indignation from the political press, but the folly of their howling is from the fact that they are "only wise after the event."

THE WORD "ELECTROTYPE."

The origin of electrical nomenclature is, as a rule, easy to trace, most of the words in use having been expressly coined by the discoverers of the phenomena which they describe, and ushered into the world under the auspices of some of the great learned societies. Thus their birth has been, so to speak, formally registered by their parent, but such is not the case with the low-born brats of the workshop. It is not always unprofitable to trace the history of a word, as it is always closely connected with the history of the thing itself. Looking at the subject from this point of view, we

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have put together, in the form of an article, a few scattered notes upon the word "Electrotype."

By way of introduction it will be well to refer to the words used to describe the process by those who were first in the field. We must, however, disown any intention of reviving the controversy as to whom the credit of this discovery really belongs. This question was fully discussed many years ago by Mr. Dircks in his tract on Electro-metallurgy. In the announcement of Jacobi's discovery in the *Athenæum* of May 4, 1839 (p. 334), the process is described as a method "of converting any line, however fine, engraved on copper, into a relief by a galvanic process." Further particulars were given to the world by Jacobi in a letter to Faraday published in the *Philosophical Magazine* for September of the same year, p. 161, where he speaks of the plates as "stereotypes in copper." In a paper by Mr. Edward Solly, dated March 2, 1840, printed in the *Philosophical Magazine* for April, the author says (p. 312) that "as the process is called 'voltaic precipitation'" it might be supposed to require a powerful battery and a considerable amount of scientific knowledge to carry it into practical effect. He goes on to say that such is not the case. It would seem from this that the word was not then known, Mr. Solly being very precise in placing the words "voltaic precipitation" in inverted commas. It probably came into use immediately after, for we find an advertisement by Edward Palmer, a philosophical instrument maker in Newgate-street, in the *Athenæum* of April 4 of the same year, in which he states that he supplies "apparatus for the electrotype, or art of copying medals." In the preface to a catalogue issued by Palmer in 1840, he refers to "the electrotype," devoting a paragraph to the advantages and utility of the new art. In the *Athenæum* for April 11 there is a paragraph stating that Mr. Barclay, a seal engraver, of 22, Gerrard-street, Soho, had sent to the office of the paper "what he calls an electrotype seal," being a copy of a seal supplied to the publisher a few years before. Advertisements from Palmer and also from Barclay appear in several subsequent numbers of the paper.

The word seems to have rapidly come into use, and it occurs several times in the *Mechanics' Magazine* of the day, and also in Sturgeon's "Annals of Electricity," vol. 5, July—December, 1840, though it is sometimes used in a sense now obsolete. For instance, in a paper on the "The Cultivation and Growth of Electrotypes," in the December number, the editor says, "a second crop of electrotype was found on the face of the first." The word is, however, also employed in its present meaning—viz., to denote the actual result of the process. We may here note that the volume above referred to contains some interesting specimens of engravings printed from electrotype plates.

It is a little curious that the late Mr. Spencer, who enjoys a large share of the credit of the discovery of electrotype, did not at first approve of the word. In a pamphlet issued by him about September or October, 1839, and noticed at great length in the *Mechanics' Magazine* for October 26, he speaks of an electrotype as "a voltaic impression." About a year later he issued "Instructions for the Multiplication of Works of Art in Metal by Voltaic Electricity," and in the preface, dated August, 1840, he says: "The forms of apparatus for producing these results have been termed by one portion of the public 'electrotypes'; by others their name included a portion of my own, neither of which I think correct. I would propose that the instruments themselves should be termed 'electrographs,' and that the whole art of applying electricity to the production of such works of art should be called 'electrography.'"

Mr. Spencer's suggestions, which are, indeed, not particularly happy, were not adopted. We never met with "Spencertype," but "Jordantype" was proposed by Mr. Dircks, who fought hard to secure the credit of the discovery for a Mr. Jordan on the strength of a letter of his which appeared in the *Mechanics' Magazine* of June 8, 1839. Jordan's claim has never been put very persistently forward except by Mr. Dircks, but as we promised to keep clear of "the horrible wrangling about priority," as Humboldt calls it, we will say no more upon this point.

It would appear, then, that the word "electrotype" was first used in an advertisement in the *Athenæum* of April 4, 1840, and that it was formed, by analogy, from "stereotype," some of the earliest applications of the process being to the reproduction of printing surfaces. It is not, perhaps, the best word, but it is handy, and the shortened form "electro" is particularly so. Anyhow, we ought to be grateful for having been spared any form of *galvano-plastik*, which was probably coined by Jacobi himself, as it occurs in the title of his pamphlet published, in German, at St. Petersburg in 1840. The preface bears date March 30 (April 11), but he gives no explanation of the origin of the word, nor does he justify or apologise for it, as most writers do when they make an addition to the vocabulary. In the same year Dr. F. A. W. Netto published at Leipzig a pamphlet, the preface to which is dated October, with the title "Anweisung zur Galvanoplastik." This form of the word, which also appears in French as *galvano-plastie*, has never found any favour in our language, and is now seldom used. In the early days of the discovery we come across paragraphs headed "galvano-plastics," and Fesquet's translation of Roseleur's manual, published at Philadelphia in 1872, has the title "Galvano-plastic Manipulations." We have also met with "galvano-plasty," but to describe electro-deposited copper as "plastic" is not consonant with the English meaning of the word.

"Electrotype" was very early adapted in Italian, but we fancy that it was soon discarded. In January, 1841, Zantedeschi read a paper before the Athenæum at Venice descriptive of the process, which he refers to as *elettrotipia*, but in the course of the paper he frequently employs *galvanotipica*. The paper was afterwards published separately, and is of some historical importance as containing some very excellent engravings printed from electrotype plates.

The word *galvanographie* was used by F. von Kobell, in the title of a pamphlet published at Munich in 1842. This term has also been used—but to a very slight extent—in English.

EARLY PRACTICAL APPLICATIONS.

There are many of the present exponents of the beauties of electrical engineering, together with the practical men engaged in actual work in the same, who rest in the idea that although laboratory experiments may have been made in the production of electric light in very early days of electrical discovery, yet that practical application of the light was not by any means possible until quite within recent years. The following extracts from the old *Electrical Magazine* (vols. i. and ii., p. 308, 314) may afford them interesting information in this respect.

In the number for April, 1844, there appears this item: "*Gas Light superseded by Electricity.* A letter from Paris, dated Oct. 21 [1843], gives the following interesting account of the first public trial of an experiment, which has been more than four years in preparation, for fixing at a public point the electric light, and making it applicable to the purpose of lighting the streets and private houses. On one of the bases of statues of the Pavilion de Lille, on the Place de la Concorde, a glass globe, of apparently twelve or thirteen inches diameter, with a movable reflector, was connected with a voltaic battery, and at a little before nine o'clock the electric light was developed in it by proper conducting arrangements. At this time, all the gas-lights of the place, about 100 in number, were burning. As soon as the electric light appeared, the nearest gas-light had the same dull, thick, and heavy appearance as oil-lamps have by the side of gas. Soon afterwards the gas light was extinguished, and the electric light shone forth in all its brilliancy. Within 100 yards of the light it was easy to read the smallest print; it was, in fact, as light as day. The astonishment of the assembled multitude was very great, and their delight as strong as their astonishment. The estimate made by scientific persons who were present was that the electric light was equal to twenty of the gas-lamps, and, consequently, that five of these lights would suffice to light the whole place most brilliantly. As regards the expense of production, nothing positive has transpired; but I think I may safely assume that it would be considerably less than that of the generation of gas, whilst the first outlay for machinery and conductors would not

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amount to a twentieth part of that required for gas works. There would also be another advantage in the electric light. It gives out no bad smell; it emits none of those elements which, in the burning of gas, are so injurious to health; and explosion would be impossible. The only danger that would arise would be at the battery itself, but that would be under the control of competent persons; and even in this respect there would be no danger, even to unskilled persons, with an apparatus of moderate size. Internal lighting would be as practicable as external lighting; for by conductors the fluid would be conveyed to every part of the house. The experiment performed last night was with a voltaic battery of two hundred pairs, composed as follows: 1st, an outer cylinder of glass; 2ndly, in this cyclinder a cylinder of charcoal, open at both ends, and plunged in nitric acid contained in the outer cylinder; 3rdly, in the cylinder of charcoal a porous porcelain tube, containing water acidulated with sulphuric acid, and within the porcelain tube a cylinder of amalgamated zinc plunged into the acidulated water. The pile was on the Pavilion de Lille, the two copper conductors from the two poles, terminated in charcoal points, within the globe, from which the air had been exhausted. The electricity produced a soft but most intense light. I understand that the experiment was considered highly successful by the authorities who were present, and that it is to be repeated upon a larger scale. Should the thing work as well in a general way as it did last night, and the cost be less than that of gas, which it must be, there will be a dreadful revolution in gas works. I have heard it asserted by persons who are acquainted with M. Achereau, the gentleman who performed the experiment last night, that a company for the supply of the electric light would realise a handsome profit on charging only a sixth of what is now paid for gas. The strength of the electric light did not appear to me to exceed that of the hydro-oxygen; but it is much more simple in the apparatus required, and much less costly in the expense of production. The hydro-oxygen requires double and most expensive apparatus, and is only applicable to a few localities. The electric light may be applied externally and internally in any place."

So much with respect to arc lights. Now with respect to the practical use of incandescent lamps. In the number for April, 1846, we read: "M. Louyet, professor of chemistry in the Brussels Museum of Industry, writes to say that he had proposed the voltaic light for mines long before M. Boussingault. He quotes the following from an article of his, published October 26, 1836, in the *Courier Belge*: "Since we are on the chapter of coal-mines, it seems to us that here is the place to express our astonishment at seeing that one of the most beautiful discoveries of modern science has not been rendered available for the illumination of the galleries. We would speak of the incandescence of charcoal produced in vacuum by means of a voltaic pile. . . . There would not be the least fear of danger, since the focus of light would be completely insulated from the external air." M. Boussingault grants that he did not entertain the idea of applying the voltaic light for the illumination of mines until June, 1845, after an accident that had happened in one of his mines. He thinks it, however, his duty to add that he did not content himself with *proposing* this means, but that he actually *employed* it to illuminate without danger an atmosphere of a most explosive character. These are the words: "incandescence of charcoal produced in a vacuum." Whether rod or filament, here is an incandescent electric light actually employed in a coal-mine in the year 1845.

With regard to the practical developments of electric motors, the following will also be found interesting: "A Berlin paper, dated the 29th of November last [1843], contains a letter to the following effect: 'Bauer, of Nuremberg, at present shows a machine which convinces all those who see it that the magnetic force may be carried to any extent that is desired. The machine is of peculiar construction. Attached to an upright iron spindle, there is a wheel of the same metal; below, there are numerous movable magnets, having motion imparted to them by a large magnet. The method of inverting the poles is quite original, being totally different from the method of Jacobi. The battery, which, however, one does not see, must be of great energy. The wheel preserves a uniform velocity of motion. The machine is employed in pounding spices, and it is well furnished, and strong in all its parts."

An account is also given at the same time, from the *Augsburg Gazette*, of an electro-magnetic carriage mounted "on ordinary railroad wheels," made by Wagner, of Frankfort-on-Main, completed December 3, 1843. "The arrangement appears to be capable of very great power, for the carriage, with machinery producing the motion, and the battery, weighs a ton and a half. The battery consists of twenty pairs of copper and zinc plates. Mr. Beil says experiments have already shown that the arrangement has sufficient power to propel, with the greatest facility, the carriage, containing from thirty to forty persons. Nothing is said of the velocity attained in these experiments."

THE E.M.F. OF CERTAIN ELEMENTS.*

Julius Miesler has determined the E.M.F. of some of the newer forms of batteries and accumulators under the same conditions, and using pure materials and especial care, so that the numbers which he has obtained are comparable. His results may be summarised in the following table:

1. Marie-Davy cell—				
	$Zn \mid H_2SO_4 \mid Hg_2SO_4 \mid C$			Total E.M.F. in volts
	1·06		0·43	= 1·5
2. Warren de la Rue cell—				
	$Zn \mid NH_4Cl \mid Ng\,Cl, Ng$			
	1·04		0·03	1 07
3. Mandet cell—				
	$Zn \mid Na\,Cl \mid KCl, C$			
	1·02		0·63	1·65
4. Planté accumulator (charged)—				
	$Pb \mid H_2SO_4 \mid PbO_2$			
	0·9		1·3	2·2
5. Böttcher accumulator—				
	$Zn \mid Zn\,SO_4 \mid PbO_2$			
	1·16		0·97	2·13
6. Sutton accumulator—				
	$Cu \mid Cu\,SO_4 \mid Pb\,O_2$			
	0·32		0·89	1·21

The value for the E.M.F. of the charged Böttcher accumulator in these determinations is worthy of notice. The author states that the difference of potential between the zinc and zinc sulphate is 0·1 higher than in his other determinations, and he attributes this to the formation of free sulphuric acid while the accumulator is being charged. On allowing this form of accumulator to run down until the lead plate became grey and the brown colour of the peroxide had entirely disappeared, he still found a difference of potential of 1·16 volt between the zinc and the zinc sulphate solution, while the difference due to the lead plate and the solution fell to 0·68 volt, making a total E.M.F. of 1·84 volt for the uncharged cell. This result was confirmed by fitting up an element with zinc and lead plates and zinc sulphate solution, which gave a precisely identical E.M.F. to that of the run-down accumulator.

Saved by the Telephone.—A book-keeper, who remained late in his employer's vault at Louisville to examine papers, was locked in by a fellow-clerk, ignorant of his presence in the safe, and left for the night. His position might have been fatal, but the telephone was fortunately fixed in the vault, and he was able to telephone to the central office. The employer was sent for, and the unfortunate clerk was rescued on the verge of succumbing to the stifling atmosphere.

* *Monatshefte für Chemie*, band viii., s. 713-720.

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ELECTRICITY AS APPLIED TO MINING.*

BY FRANK BRAIN, M.E.

This is a paper from the mining engineers' standpoint, briefly sketching the known applications of electricity to mine working up to the present time.

The writer regrets there is little to add to what has already been made public. He cannot but express surprise that a power which it is apparent has now passed the range of experiment, and is developing itself economically and efficiently, should not have been made greater use of than appears to have been the case hitherto. The recommendations of the Mines Commission, and the passing of the more stringent Coal Mines Act of 1887, have both stimulated mine managers to inquire into and recognise the advantages of electricity for blasting and lighting. By means of a small hand magneto-battery and electric fuzes, all the shot-firing in most of the fiery collieries is now done, the explosive used being one of the many lately introduced, which,

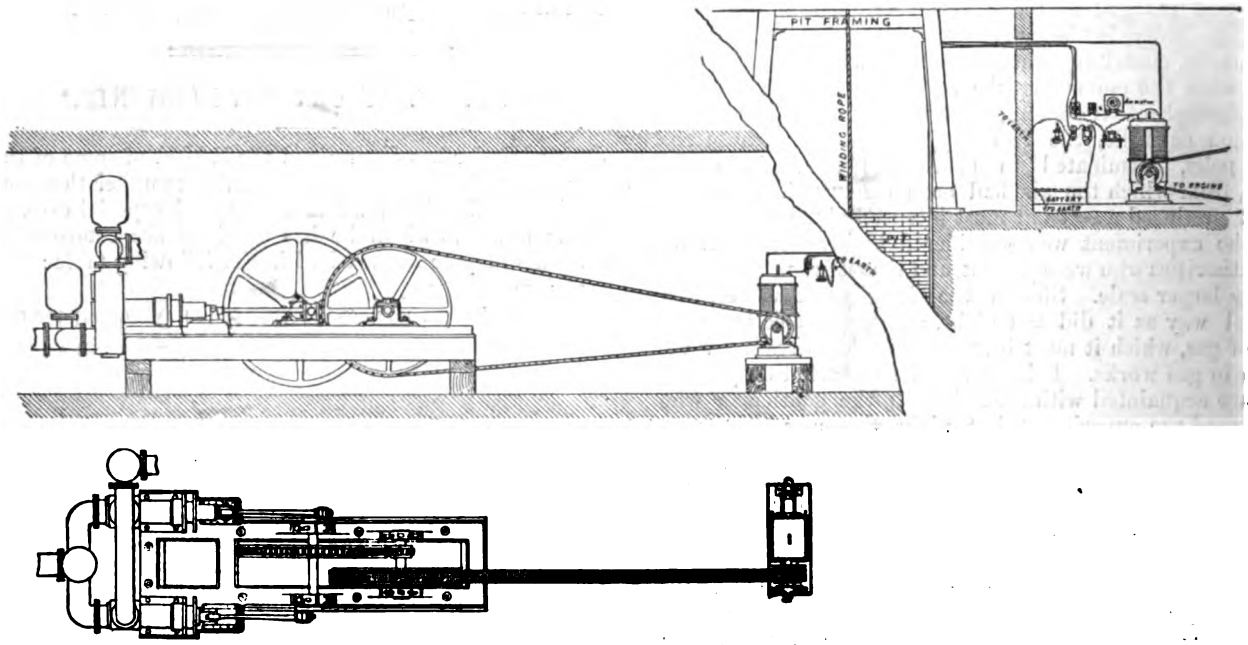

FIG. 1.

fired by an electric detonator, gives off no flame. Dynamo machines at many pits are used for lighting the surface and main roadways of the colliery, and this current has been also used for the purpose of shot firing, notably at Ynyshire Colliery, Rhondda Valley, South Wales. All the shots are fired in this way simultaneously, with every man out of the pit, thus putting loss of life beyond possibility. This adaptation, it should be said, however, is protected by a patent.

The adoption of the electric lamp in place of the well-known safety lamp is now very strongly advocated. There are several in the field, notably the Swan and Pitkin, secondary batteries, and the Schanschieff, a primary battery. The South Wales Institute of Engineers (who have referred the matter to a special committee), with other kindred societies, have lately had these and other lamps put before them, and several colliery engineers are practically testing them. One, Mr. G. W. Wilkinson, of Risca, has in daily use several hundreds, and so satisfied is he with their results that he has ordered a further number for other collieries of his. The lighting of the main roadways by electricity is common in many mines. Mr. Sopwith, of the Cannock Chase Collieries, who, it will be remembered, read a paper in connection with the 1886 meeting of the British Association on the subject, informs me his plant, which has since been extended, continues working well. He has lately introduced large accumulator cells to supply twelve volt lamps in various parts of the colliery workings, where moisture and a very bad roof had to be contended with. He found there was no difficulty with the leads, and the result was in every way satisfactory.

The applications of electricity to transmission of power are confined to a few collieries, so far as the writer knows, in Great Britain, to three only—viz.: Trafalgar Colliery, Forest of Dean; St. John's Colliery, Normanton; and Allerton Main Colliery, Leeds. At Trafalgar, what was a very small pumping plant started in December, 1882, developed in May, 1887, into three sets of plant, doing the greater part of the underground pumping of the colliery. As the writer has been directly concerned in the working of this plant, a brief description of the last installation may be interesting.

The pump, a double throw 9in. plunger, with 10in. stroke, is fixed 2,200 yards from the generator and 1,650 yards from the bottom of the pit shaft. The pipe main is 7in., and at a maximum speed of 25 strokes, the pump lifts 120 gallons per minute 300ft. high. It is geared 6 to 1, the small pinion being driven by a belt from the motor (an Elwell-Parker). Current is conveyed to the motor by a conductor of nineteen No. 16 wires, insulated and carried on earthenware insulators. An old 4in. iron wire rope serves for the return current. The current is 43 amperes and the E.M.F. 320. The cost of engine and electric plant was £644. The weekly cost of maintenance, allowing 15 per cent. for interest and depreciation on plant, £7. 17s., or ·002 of a penny per h.p. per hour, and the economy effected about £500 per annum. The power lost and useful effect in the different stages is as follows:

Indicated H.P. of Steam Engine 29·49.

Received by		Loss in		Useful effects.
Generator...	23·00	Steam engine.	22 per cent.	78 per cent.
Cables	18·44	Generator ...	20 ,, ,,	80 ,, ,,
Motor	14·99	Cables.....	20 ,, ,,	80 ,, ,,
Pump	11·99	Motor	20 ,, ,,	80 ,, ,,
Water	10·36	Pump	14 ,, ,,	86 ,, ,,

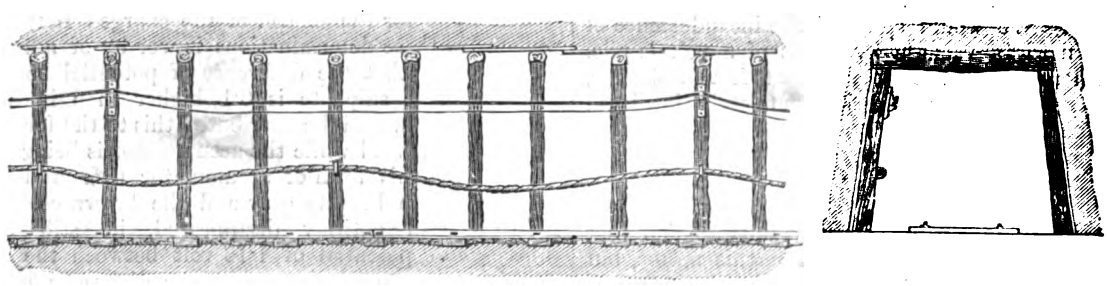

FIG. 2.

The efficiency obtained throughout is only 35 per cent., but it will be noticed the engine, which is an old one, loses 6·49 h.p., or 22 per cent. alone. This plant has worked daily since May, 1877, without interruption, and is giving every satisfaction.

Figs. 1 and 2 are views of the pump, showing its connection with the motor, and of the leads along the underground roads.

Fig. 3 is a diagram divided into 22,000 watts (29·49, the indicated h.p. of engine), showing the percentage of loss at each stage, commencing with the engine, and also the effective work (35 per cent.).

Fig. 4 is prepared in a similar way, but takes the h.p. delivered to generator (23·0) as its starting point, thus showing the proportion of power given off by steam engine belt used to lift water to be 45 per cent.

Fig. 5 shows the useful effect obtained at the various stages.

At St. John's Colliery, Normanton, 39 gallons per minute are raised 530ft., equal to 6·3 h.p. work done. This is with an old girder engine which indicates 14·2 h.p. The efficiency, therefore, is 44·4 per cent. This plant commenced working in the latter part of 1887. In the early part of this year (1888), so satisfied were the owners of the

* Paper read before the British Association at Bath.

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colliery with its working, that they laid down what is at present the largest electrical pumping plant in England; 120 gallons per minute are raised 900ft., equal to 33 h.p. nearly. The engine has not been indicated, which is to be regretted, but there is an output of 53 h.p. from the generator, so that the efficiency, comparing the actual work done with the output of the dynamo, is about 62 per cent. The current averages 66 amperes with an E.M.F. of 600 volts. Immisch motors are used here. These extensions speak for themselves.

At Allerton Main Colliery, very small quantities of water are being dealt with at inaccessible points, the power being taken to the motors in secondary batteries charged at the surface and conveyed in the colliery tubs. Mr. Blackburn, the manager of these collieries, has also in work a coal-cutting machine. The motor is carried upon the bed-plate of the machine, a rotary motion being transmitted to the shaft carrying the cutter bar through gearing. The current is conveyed to the coal face from the dynamo placed on the surface by a flexible cable.

The author alluded to the use of the electric current for hauling purposes at the collieries of Zankerode, and Paulus, and Hohenzollern, in Germany, and the Stassfurt salt mines and the Salzberg works. Turning to Australia, he said the only installation he could trace was that at the Phœnix Gold Mines in New Zealand.

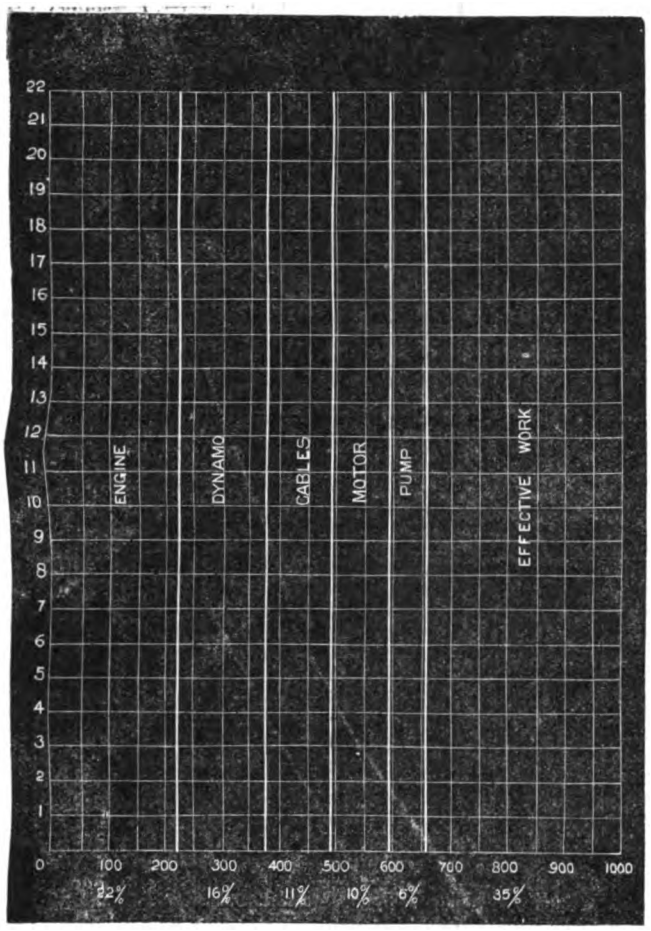

FIG. 3.

In America, the use of electric motors is much more extended than with us. The electric light companies hire them out for varied purposes, their large central lighting stations enabling them to do this to great advantage. Horses on street tramways are being fast replaced by the electric locomotive. For example, in one city alone—Richmond, Va.—with grades of 3 to 10 per cent., 200 cars driven by Sprague motors on the overhead conductor system are running daily, carrying some 80,000 passengers per week. It is stated that the economy, as compared with horses, is 25 per cent. on gross receipts. It is but lately that attention has been turned to mine work; but now they have commenced with the push and spirit of enterprise which is a distinguishing feature with American engineers, we find them making great progress. At Silver City, Idaho, a Sprague motor is driving a fifty-stamp mill four miles away from the generator. The latter, which gives off 75 h.p., is driven by a turbine. It is stated by the manager of this mine that he saves on the haulage of his ore alone 80 dollars per day. At Veteran Tunnel, Aspen, Colorado, two sets of rope haulage drums are working with 10 h.p. Sprague motors, and a third is being erected. These draw six trams at the rate of 500ft. per minute up a 3 per cent. grade. The Lykins Valley Coal Company, at the Short Mountain Colliery, Pa., in the autumn of 1877, started an electric locomotive, which has since continued doing good work. The motor, a 25 h.p. Schlœsinger, is connected to the locomotive wheels by chain gearing, and after six months' running the teeth of the pinion show a wear of only 1-64th of an inch. It receives the current through a side conductor from a 50 h.p. generator. The length of the track is 6,300ft., and it is hauling daily, at a speed of from six to eight miles per hour, some 500 tons per day. The time taken to make an all-round trip is about fourteen minutes, as compared with fifty minutes when mule-power was employed. The most stupendous set of electric mining plant in existence, so far as the writer knows, is now working at Big Bend Tunnel Camp, Butte Co., California. A tunnel, 16ft. by 12ft., and two miles one-third long, is cut from the Feather River through the mountain. A permanent dam is built across the river just below the head of the tunnel, by which the river is diverted

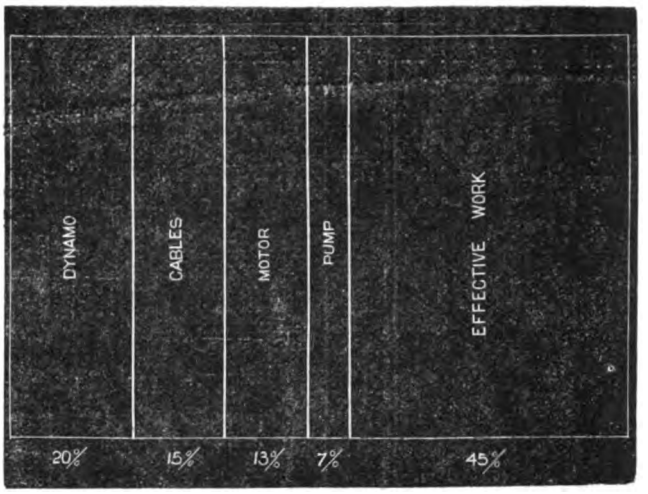

FIG. 4.

from its channel, and made to flow through the tunnel, thus drying up the bed of the river. A canal, two miles long, is constructed from the tail end of the tunnel, by which a fall of 300ft. is obtained. Here powerful Pelton water-wheels are fixed, driving the dynamos (Edison's). The working E.M.F. is 1,000 volts. The conductors are double, metallic, and extend a distance of 18 miles, delivering electricity at 14 different points in the circuit where power is required for winding, pumping, &c. Some 10 to 20 Sprague motors, varying from 5 to 50 h.p., are worked by branch conductors from these various stations. The potential at the motors varies from 500 to 700 volts. It is apparent where water-power can be thus applied. The saving, when compared with the use of fuel, is very

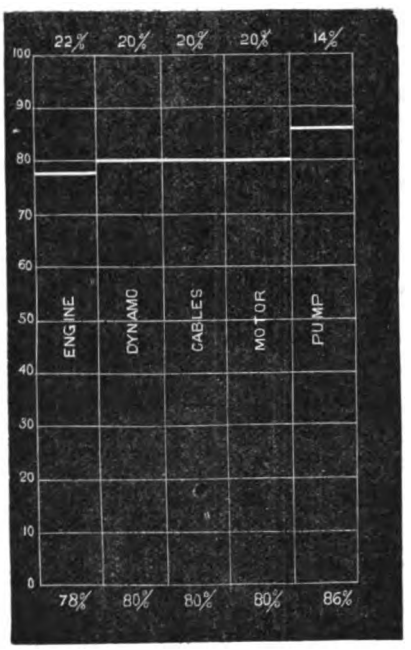

FIG. 5.

considerable, especially so in metal or diamond mining districts where coal is expensive. The ease with which any power can be conveyed over hill and dale and into the intricacies of the mine, these are factors of no mean importance.

It will be seen by this review of the more important applications of electricity to mining at present in existence, how very little progress, comparatively speaking, has been made in this respect; and yet it is proving in every instance where it has been adopted, a commercial success, and its application has been invariably extended. No doubt want of familiarity deters some engineers. They look upon electricity as a new idea, a something which cannot be explained, and as not to be relied upon when compared with steam, compressed air, water under pressure, and other well-known applications of power. The drawbacks and shortcomings of these are admitted, but yet they are preferred

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because of their certainty of action and known properties. Many look upon electricity as yet in a transition stage, but it is not so. The efficiency of the machine is now so great, the price so moderate, and men of such high standing and repute are now engaged in their development, that there need be no fear or hesitancy. Electricity has passed beyond the range of theory and experiment. It is now a power in the world, and that power will increase mightily. The writer will be amply repaid if, by the perusal of this *résumé*, any of his fellows are induced to take up the matter for themselves. He is satisfied that under many conditions common in mine working electricity can and will be applied successfully and economically.

DISCUSSION ON THE PAPERS OF MESSRS. SELLON, BRAIN, AND WATTS.

A variety of incandescent miners' lamps were shown alight in illustration of Mr. Watt's paper, which appeared in our issue of Sept. 14th. Mr. Sellon's paper was given in the following number.

Mr. S. F. Walker said he had been engaged in mining work for a long time, and very uphill work it was. Papers such as had just been read would do more for electric lighting in mines than anything else. Amongst the lamps that had been mentioned was one attached to his name, but no sample of it was shown. The reason was that he had not yet got it up to a point which he thought practical. There were several difficulties to be overcome in this class of lamps. One was to prevent the liquid spilling, and another to make the connections in a simple and automatic way, and provide against the acids getting into them. Mining engineers would not countenance any lamp unless it was provided with a gas detector. Mr. Macquay had designed a gas detector in which a change of colour in the lamp would tell when the gas was present and what percentage of it.

Mr. Carpenter said Mr. Swan had told him that with his apparatus he had been able to determine the percentage of fire-damp present to within ¼ per cent. Referring to Mr. Brain's paper, he thought the first installation for the transmission of power was that at Dunedin.

The **President** (Col. Cunningham occupied the chair in the absence of Mr. Preece) asked Mr. Sellon whether the percentage of vessels using the electric light for passing through the Suez Canal was not calculated on the largest tonnage? In Mr. Brain's paper it was stated that shot firing in mines by means of electricity was protected by patent. He supposed this referred to some special method, because this application of electricity was not new.

Mr. Sellon, in reply, said no doubt the 40 per cent. of vessels using the electric light was calculated on the largest tonnage.

Mr. Brain said the method of shot firing mentioned as patented in his paper was a new one.

The **President,** in proposing a vote of thanks to Messrs. Sellon, Brain, and Watts, said the use of the electric light for traversing the Suez Canal by night had been in every way a great improvement on the old method of navigating it. He had not the least doubt that more than 40 per cent. of the vessels passing through it used the electric light. This was the greatest improvement made in connection with the canal since it had been opened. Mr. Brain's paper on the application of electricity to mining was most interesting. No doubt in course of time these applications would become more and more numerous. Mr. Watts's paper on miner's lamps was a useful *résumé* of what had been done in this direction. The principal difficulty seemed to be their price, and they were all rather heavy. There was no doubt they would be extremely useful in fiery mines, and soon no others would be used. He was sorry Mr. Swan was not there, and so they had lost a description of his fire-damp indicator.

FIVE APPLICATIONS OF FOURIER'S LAW OF DIFFUSION, ILLUSTRATED BY A DIAGRAM OF CURVES WITH ABSOLUTE NUMERICAL VALUES.*

BY SIR WILLIAM THOMSON.

1. Motion of a viscous fluid.
2. Closed electric currents within a homogeneous conductor.†
3. Heat.
4. Substances in solution.
5. Electric potential in the conductor of a submarine cable.‡

1. Fourier's now well-known analysis of what he calls the "linear motion of heat" is applicable to every case of diffusion in which the substance concerned is in the same condition at all points of any one plane parallel to a given plane. The differential equation of diffusion* for the case of constant diffusivity, κ, is

$$\frac{dv}{dt} = \kappa \frac{d^2 v}{dx^2},$$

where v denotes the "quality" at time, t, and at distance, x, from a fixed plane of reference. This equation, stated in words, is as follows: Rate of augmentation of the "quality" per unit of time is equal to the diffusivity multiplied into the rate of augmentation per unit of space of the "quality."

The meaning of the word "quality" here depends on the subject of the diffusion, which may be any one of the five cases referred to in the title above.

2. If the subject is motion of a viscous fluid, the "quality" is any one of three components of the velocity, relative to rectangular rectilineal co-ordinates. But in order that Fourier's diffusional law may be applicable, we must either have the motion very slow, according to the special definition of slowness in article xcvii., or the motion must be such that the velocity is the same for all points in the same stream-line, and would continue to be steadily so if viscosity were annulled at any instant. This condition is satisfied in laminar flow, and more generally in every case in which the stream-lines are parallel straight lines. It is also satisfied in the still more general case of stream-lines, coaxial circles with velocity the same at all points at the same distance from the axis. Our present illustration, however, is confined to the case of laminar flow, to which Fourier's diffusional law for what he calls "linear motion" (as explained above in section 1) is obviously applicable without any limitation to the greatness of the velocity in any part of the fluid considered (though with conceivably a reservation in respect to the question of stability).† In this case the "quality" is simply fluid velocity.

3. If the subject is electric current in a non-magnetic metal, with stream-lines parallel straight lines, the "quality" is simply current density, that is to say, strength of current per unit of area perpendicular to the current. The perfect mathematical‡ analogy between the electric motion thus defined and the corresponding motion of a viscous fluid defined in section 2 was accentuated by Mr. Oliver Heaviside in the *Electrician*, July 12th, 1884; and in the following words in the *Philosophical Magazine* for 1886, second half-year, p. 135: "Water in a round pipe is started from rest and set into a state of steady motion by the sudden and continued application of a steady longitudinal dragging or shearing force applied to *its boundary*. This analogue is useful because everyone is familiar with the setting of water in motion by friction on its boundary, transmitted inward by viscosity." Mr. Heaviside well calls this analogue "useful." It is, indeed, a very valuable analogy, not merely in respect to philosophical consideration of electricity, ether, and ponderable matter, but as facilitating many important estimates, particularly some relating to telephonic conductors and conductors for electric lighting on the "alternate current" system. In a short article to be included in vol. iii. of my collected papers, which I hope will soon be published, I intend to describe a generalisation, with, as will be seen, a consequently essential modification of this analogy, by which it is extended to include the mutual induction between conductors separated by air or other insulators, and currents in solids of different conductivity fixed together in contact.

4. If the subject is heat, as in Fourier's original development of the theory of diffusion, the "quality" is temperature.

5. If the subject is diffusion of matter, the "quality" is density of the matter diffused, or deviation of density from some mean or standard density considered. It is to Fick, 33 years ago demonstrator of anatomy, and now professor of physiology in the University of Zurich, that we owe this application of Fourier's diffusional theory, so vitally important in physiological chemistry and physic, and so valuable in natural philosophy generally. When the substance through which the diffusion takes place is fluid, a very complicated but practically important subject is presented if the fluid be stirred. The exceedingly rapid progress of the diffusion produced by vigorous up-and-down stirring, causing to be done in half a minute the diffusional work which would require years or centuries if the fluid were quiescent, is easily explained; and the explanation is illustrated by the diagram of curves, section 7 below, with the time-values given for sugar and common salt. Look at curve No. 1, and think of the corresponding curve with vertical ordinates diminished in the ratio of 1 to 40. The corresponding diffusion would take place for sugar in 11 seconds, and for salt in 3½ seconds. The case so represented would quite correspond to a streaky distribution of brine and water, or of syrup and water, in which portions of greatest and least salinity or saccharinity are within half a millimetre of one another. This is just the condition which we see, in virtue of the difference of optic refractivity produced by difference of salinity or of saccharinity, when we stir a tumbler of water with a quantity of undissolved sugar or salt on its bottom. If water be poured very gently on a quantity of sugar or salt in the bottom of a tumbler with violent stirring up guarded against by a spoon, the now almost extinct Scottish species called "toddy ladle" being the best form, or, better still, a little wooden disc, which will float up with the water; and if the tumbler be left to itself undisturbed for two or three weeks, the condition at the end of 17×10^5 seconds (twenty days) for the case of sugar, or $5{\cdot}4 \times 10^5$ seconds (six days) for salt, will be that represented by No. 10 curve in the diagram.

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* Paper read before the British Association at Bath.

† This subject is essentially the "electro-magnetic induction" of Henry and Faraday. It is essentially different from the "diffusion of electricity" through a solid investigated by Ohm in his celebrated paper "Die Galvanische Kette mathematisch bearbeitet," Berlin, 1827; translated in Taylor's *Scientific Memoirs*, vol. ii., part viii., "The Galvanic Circuit investigated Mathematically," by Dr. G. S. Ohm. In Ohm's work electro-magnetic induction is not taken into account, nor does any idea of an electric analogue to inertia appear. The E.M.F. considered is simply that due to the difference of electrostatic potential in different parts of the circuit, unsatisfactorily, and even not accurately, explained by what, speaking in his pre-Greenian time, he called "the electroscopic force of the body," and defined or explained as "the force with which the electro-cope is repelled or attracted by the body," the electroscope being "a second movable body of invariable electric condition."

‡ This subject belongs to the Ohmian electric diffusion pure and simple, worked out by aid of Green's theory of the capacity of a Leyden jar (see "Mathematical and Physical Papers," vol. ii., art. lxxiii.).

* See "Mathematical and Physical Papers," vol. ii., art. lxxii.

† See "Stability of Fluid Motion," section 28, *Philosophical Magazine*, August, 1887.

‡ It is essentially a mathematical analogy only; in the same sense as the relation between the "uniform motion of heat"; and the mathematical theory of electricity, which I gave in the *Cambridge Mathematical Journal* 46 years ago, and which now constitutes the first article of my "Electrostatics and Magnetism," is a merely mathematical analogy.

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6. If the subject be electricity in a submarine cable, the "quality" is electric potential at any point of the insulated conductor. It is only if the cable were a straight line that x would be (as defined above) distance from a fixed plane; but the cable not be laid along a straight line, and the proper definition of x for the application of Fourier's formula to a submarine cable is the distance along the cable from any point of reference (one end of cable, for example) to any point of the cable. For this case the diffusity is equal to the conductivity of its conductor, reckoned in electrostatic units, divided by the electrostatic capacity of the conductor per unit length insulated, as it is, in gutta-percha, with its outer surface wet with sea-water, which, in the circumstances, is to be regarded as a perfect conductor. For demonstration of this proposition see vol. ii., art. lxxviii. (1855), of my collected papers.

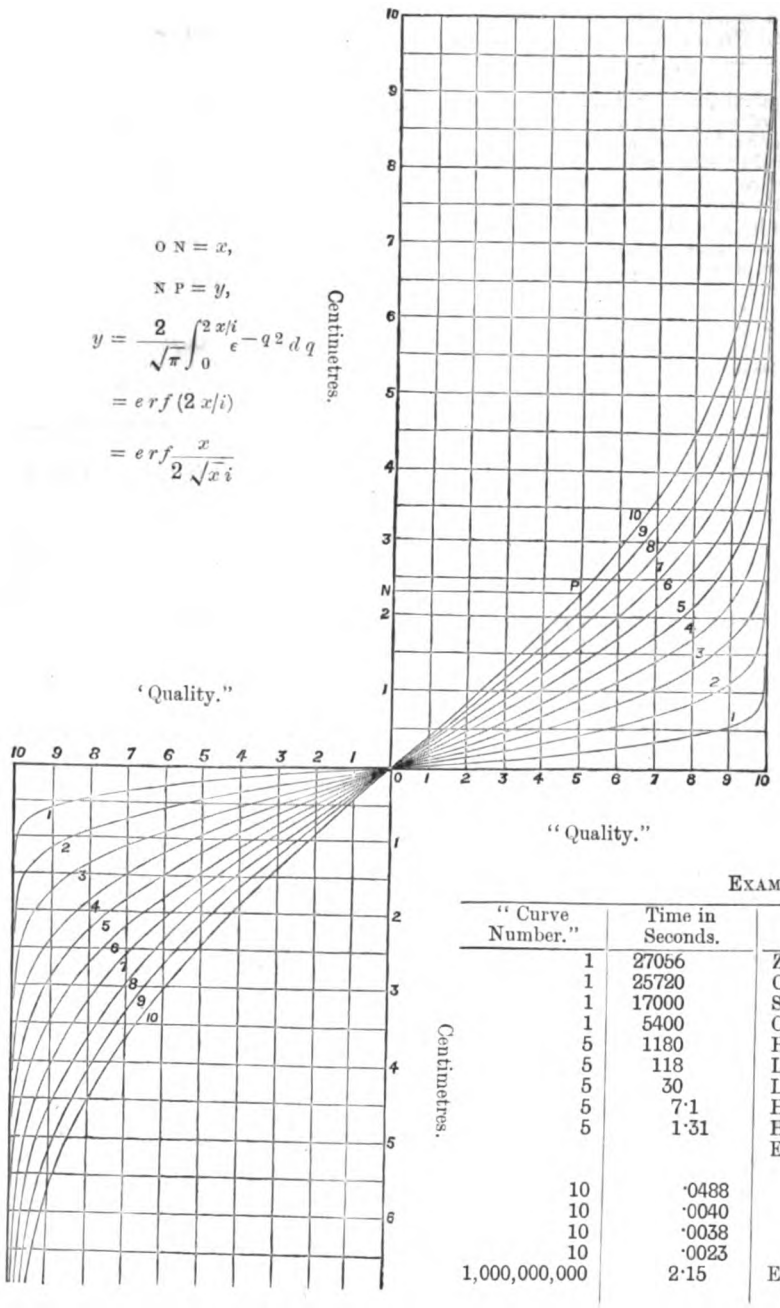
Subject of Diffusion.	"Quality" represented by $\frac{1}{10}$ N.P.
Motion of a viscous fluid.....	Ratio of the volicity at N to the constant velocity at O.
Closed electric currents within a homogeneous conductor	Current density.
Heat	Ratio of temperature *minus* mean temperature to mean temperature.
Substance in solution	Ratio of density *minus* mean density to mean density.
Electric potential in the conductor of a submarine cable	Ratio of potential at N to constant potential at end O.

7. Explanation of Diagram Showing Progress of Laminar Diffusion.

In each curve—

$$\frac{1}{10}\,\text{N P} = \frac{2}{\sqrt{\pi}}\int_0^{2x/i} dq \cdot \epsilon^{-q^2},$$

Showing Progress of Laminar Diffusion.



Examples:

"Curve Number."	Time in Seconds.	Case of Diffusion.
1	27056	Zinc sulphate through water.
1	25720	Copper sulphate through water.
1	17000	Sugar through water.
1	5400	Common salt through water.
5	1180	Heat through wood.
5	118	Laminar motion of water at 10° cent.
5	30	Laminar motion of air.
5	7·1	Heat through iron.
5	1·31	Heat through copper.
		Electric current in a homogeneous non-magnetic conductor:
10	·0488	Copper.
10	·0040	Lead.
10	·0038	German-silver.
10	·0023	Platinoid.
1,000,000,000	2·15	Electric potential in the Direct U.S. Atlantic cable.

where x denotes the number of centimetres in O N, and i the "curve number." The curves are drawn directly from the values of the integral given in Table iii. appended to De Morgan's article "On the Theory of Probabilities," "Encyclopædia Metropolitana," vol. ii., pp. 483—84.

N P denotes the "quality" (defined below) { at distance = O N from initial surface or interface, and at time equal in seconds to ["curve number"]² divided by 16 times the diffusivity in square centimetres per second.

THE SPECIFIC RESISTANCE OF PURE COPPER.

BY WALTER T. GLOVER.

The introduction of the electric light, whilst effecting many improvements in electrical manufactures, has, in one ess ntial particularly, aided in developing an improvement which had already commenced, and which had been principally initiated and carried on by the development and extension of submarine telegraphy.

The increased length of submarine cables drawing attention to the necessity of decreased resistance in the conductor employed, naturally brought with it, as the result of most careful testing, a more perfect

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system, and the production of a quality of copper of greatly increased purity, as this necessity became apparent and was insisted on.

Whilst the original cables submerged in 1853-4 between England and Holland had a conductor consisting of a copper wire with a conductivity of about 50 per cent. of pure copper, the latest form of submarine cables now possess a conductor equal to and exceeding 96 per cent. of pure copper.

The especial attention given to the electrical qualities of the copper wire used for telegraphic and telephonic external work has tended in the same direction of obtaining a material of greater electrical efficiency, and, lastly, the electric light has still further added a strong stimulus to the smelter and to the wire manufacturer to produce a metal of the best possible conductivity.

It can be well understood of what great importance a difference of two or three per cent. of conductivity of an electric light cable would make in the economical working of an installation. An increase in the resistance of an electric circuit may practically be assumed to mean a corresponding increase in the cost of the production of the motive power and an increased item of the general expenditure for maintenance.

The lowness of the conductivity of the copper conductor must be met by the increased cost of construction by the employment of a larger conductor, or by the increased cost of maintenance.

These results have, however, been avoided by the great improvements in manufacture, whereby a material is now produced of a much higher specific conductivity than was formerly thought possible for ordinary commercial use.

This result has produced an apparent anomaly, for it is now not infrequently the case that "hanks" of copper wire are manufactured which, on undergoing careful tests for conductivity at the works where they are to be used, are actually found to possess a *higher conductivity* than that assigned to absolutely pure copper of the same gauge.

Numerous instances of this fact were given by Mr. Willoughby Smith in a communication addressed by him to the Society of Telegraph-Engineers and Electricians some time back, in which some samples came out 4 per cent. in excess of the standard of pure copper.

If these were isolated cases, it would not be unnatural to suppose that some error had occurred in the tests, but similar observations have so often been noticed that one is inevitably led to the conclusion that the standard usually accepted as that represented by pure copper must be an erroneous one, and one which should require recalibration.

A reference to various text-books, tables, &c., will show that whilst a certain amount of difference exists in the various standards given as the base of the tables, there is a general unanimity in describing the standard as obtained from determinations by Dr. Matthieson. The experimental investigation by Dr. Matthieson into the specific conductivity of the various metals were carried out more than 15 years ago, and it is evident that the quality or purity of the metal experimented with at that time was, as regards copper, different from the quality or the purity which can be obtained at the present time.

The table produced by my firm, and which has been found everywhere a most useful help in electrical calculations and observations, is based upon one of Dr. Matthieson's tests, but owing to the present quality of copper produced it represents more nearly commercial copper than that which is considered as absolutely pure copper. The question of the wire gauge having now been definitely settled in favour of the Board of Trade's standard wire gauge, I feel that the British Association for the Advancement of Science may, with the greatest advantage to both the scientific and commercial world, advance a step further in this direction by instructing their committee on electrical standards to at once commence a series of definite experiments to determine what is the "specific resistance of pure copper."

We shall have the greatest satisfaction in being large manufacturers of every variety of copper conductors for electrical purposes, in supplying the committee with all their requirements, so far as this metal is concerned; and, as the experimental investigation must of necessity be carried out at some considerable expense, and not being aware of how far the finances of the association will enable them to place a grant at the disposal of the committee, we wish to mark our sense of the great scientific and commercial importance of this undertaking by contributing towards the determination of an authorised standard of the specific resistance of pure copper.

On the final determination of this standard, we would prepare suitable tables, based on the British standard gauge, which should be available for all branches of the profession for reference and calculations.

ELECTROCALORIMETRY.*

BY PROF. W. STROUD AND MR. HALDANE GEE.

In this paper the authors described improvements in their calorimeters and the results obtained during the past year. Whilst Joule, Pfaundler, and others calculated the specific heat of liquids from the rise of temperature observed on passing electric currents of known intensities through the liquids, the authors strive to effect a rise of temperature in the liquid under examination equal to that in the standard liquid—water—by either adjusting the length of the resistance coil heated, or the quantity of liquid operated upon. The latter method answers best; either would be independent of the influence of radiation and any irregularity of the resistance coils employed. The two calorimeters, the standard and the working vessel, are cylindrical, and of thin hard-rolled brass, 50 grammes in weight and ¾ litre capacity. Platinoid coils, doubly wound with silk impregnated with paraffin, and about one ohm resistance per yard, fitted to a screw plug, dip into each vessel; the standard vessel further contains a thermometer. The two chambers are placed close to one another, and connected by a short tube which contains a thermopile to indicate any difference of temperature in the two vessels. The first calorimeters constructed were provided with special apparatus for stirring. Now the authors pack the two chambers in cotton wool within a large brass cylinder and agitate them freely; care has only to be exercised that the cylinder lies horizontally afterwards, as otherwise the two faces of the thermopile would be acted upon by layers of different temperature. The substitution method generally preferred is as follows: Both calorimeters are first filled with equal masses of water raised to equal temperature; the current is passed through, and thus nearly equal quantities of heat are imparted to both; the total rise of temperature θ is noted on the thermometer as well as the small difference of temperature between the two, $d\theta$, as indicated by the thermopile. Next the water in the working vessel is replaced by the liquid to be tested, the quantity being so adjusted by previous experiments that the two liquids have approximately equal thermal values. Thus the new θ^1 and $d\theta^1$ are found for m^1. The specific heat is then $\sigma = \frac{m}{m^1}\left(1 + \frac{d\theta}{\theta} - \frac{d\theta^1}{\theta^1}\right)$. Since the θ may be small, the method is not dependent for its accuracy upon the thermometer, and a high accuracy can be attained. The tests have as yet been confined to water and alcohol, and to the degrees of accuracy attainable. The standard water is coloured to detect any possible leak. The authors are no longer in favour of bolometers, but advocate thermopiles, respecting which they added some very interesting information that might well have been made the subject of a special paper, as Prof. Cargill Knott, of Tokio, remarked. The common bismuth-antimony couple is—on account of its great resistance—inferior to a bismuth-copper couple. The sections of the latter should be in proportions of 100 to 8·49. If the efficiency of such a couple is set to equal 100, then the bismuth-antimony equals 66, iron-nickel 22, and iron german silver 10. A pile of the last type with twelve iron german silver junctions has been selected for the calorimeter. The great importance of having accurate instruments of this kind for various measurements was accentuated by Prof. Knott, Mr. Joly, and others, who also agreed that Regnault, whom various experimenters thought they had corrected, was finally always found to have been in the right. Prof. Fitzgerald believed that a properly arranged bolometer would also be applicable, and inquired whether the vapours above the liquid in the partially filled vessels might not, through their latent heat, affect the results. Prof. Stroud replied that the corrections for these effects were easily made.

* Paper read before the British Association at Bath.

COMPANIES' MEETINGS.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.

The thirtieth ordinary general meeting of this Company was held on Wednesday, at the offices in Old Broad-street, Sir J. Pender in the chair.

In the report the Directors stated that numerous small repairs had been effected by the Company's maintenance ships during the half-year, but no interruptions of a serious nature occurred until the 30th June, when both the Java-Australian cables were suddenly and simultaneously interrupted in deep water about 220 miles from Banjoewangie. The Company's steamship "Recorder" was immediately despatched from Singapore to effect repairs, and special steamers were chartered by the Company and the South Australian Government to carry telegrams between Java and Australia during the interruption. At first some difficulty was experienced by the steamship "Recorder" owing to the prevalence of bad weather and the ends of the cables being deeply buried, but communication was successfully restored on the 18th of July, and the second cable was also repaired on August 6, when it was found that the interruptions had been caused by volcanic action. In consequence of the serious inconvenience to the telegraphing community occasioned by these unfortunate interruptions, and in order to avert a recurrence as far as possible, the Directors immediately decided to lay an additional cable from Banjoewangie to Western Australia, to connect with the land lines of that colony, avoiding, as far as practicable, the volcanic region. This line would give the colonies the advantage of a third cable to Java, and an alternative land system, *via* Perth and Eucla, to the existing overland line between Port Darwen and Adelaide. The announcement appeared to have given much satisfaction in the Colonies and elsewhere. A contract had been entered into with the Telegraph Construction and Maintenance Company for manufacturing and laying this cable, which was expected to be in working order early next year.

The **Chairman**, in moving the adoption of the report, said that the gross receipts for the past half-year amounted to £239,926, as against £219,201 for the corresponding half of 1887, showing an increase of £20,725, due to a general increase of business throughout the system. The working expenses had been £69,297, against £76,241, or a decrease of £6,944, of which nearly £4,000 was for the repairing of ships—a fluctuating item—the remainder being spread over the general working. The net revenue for the half-year was £125,804, against £97,662, showing an increase of £28,142. An interim quarterly dividend of 1¼ per cent. had been paid during the half-year, and another of like amount would be distributed on the 16th inst., leaving £47,903 to be carried forward, after a charge against revenue of £15,401, balance of the cost of completing the renewal of the Singapore-Saigon cable. The Directors were adhering to their policy, accepted by the shareholders, in regard to paying the bonus, not half-yearly, but at the end of the year, when the accounts of the Company were made up. There were special reasons justifying that policy. One was that the

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Directors kept in hand such a sum as they now carried forward, and maintained in the market a more uniform rate for the shares of the Company. Those who held the shares as a permanent investment had the advantage of seeing the property from day to day rather increasing than decreasing. On the other hand, those who were disposed to sell their shares at any particular period during the three months or six, got a higher market price than they would obtain if there were a smaller reserve. Another reason had relations to interruptions. There had been two during the six months in the Australian system. Both occurred within an hour, and arose from volcanic action. The result was for nineteen days the Company were without any communication with Australia. That might have had the tendency of causing a panic in regard to the Company's property, but the large reserve proved the strength and stability of the Company, and the time passed on without any material difference in the value of the property. The Directors learned one important lesson, however. The cables concerned being laid in a volcanic region were thus rendered unsafe and uncertain, and, therefore, they resolved to have a third cable to connect Banjoewangie with Western Australia. The advantage was that the connection was with a land system in Western Australia, and at a point which would give a thoroughly efficient system by providing an alternative route of communication with the Australian Colonies. The cable was laid with the approval both of the Western Australian Government and the home Government. It had also the advantage of putting aside the competition that was threatened to lay a line from a certain point in Western Australia to Ceylon, and left this Company masters of the position. These operations, if they did not add to the dividends at present, gave a greater amount of permanency to them.

The **Marquess of Tweeddale** seconded the adoption of the report.

The motion was agreed to unanimously, and, with a vote of thanks to the Chairman, the meeting concluded.

COMPANIES' REPORTS.

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.

The following report has been issued to the shareholders of this Company: "In compliance with the request of several shareholders, and in view of many important events during the last few months, the Directors, while not anticipating the approaching annual report, consider that a brief statement as to the present position of the Corporation as regards prominent questions may be of interest. By the Electric Lighting Amendment Act, which received the Royal assent on 28th June, 1888, the chief obstacles to the investment of capital in central lighting stations have been removed. Although the alteration of the law does not meet all wishes, nevertheless the extension from 21 to 42 years of the period after which the local authorities can require the undertakers to sell, and the improvement in the terms of purchase which the Act effects, will be of material benefit to the industry. There are, indeed, good grounds for hoping that the recent amendment of the Act of 1882 will prove a turning-point in the history of the industry, and there are already many indications that the long anticipated revival in the electric lighting business is now at hand. Among the electric lighting companies which have already been formed for the supply of electricity, may be mentioned the Chelsea Electricity Company, in which the Corporation are interested as contractors for the generating plant. This Company, which has been established for the purpose of supplying electricity to one of the most important residential districts of London, possesses a provisional order which secures to the Company the benefit of the new Act. It proposes to put down plant in the first instance sufficient to supply 6,000 lights. The system of distribution which is being adopted is one in the economy and efficiency of which the Directors have the fullest confidence. The electricity generated at the central station will be conveyed by underground mains to sub-centres, where accumulators, which the Electrical Power Storage Company are supplying, will be charged. From these storage stations the current will be distributed to the surrounding buildings. The Corporation have also made arrangements for establishing central stations at Bournemouth and other places. The negotiations with the Commissioners of Sewers, with a view to the electric lighting of a part of the City of London, have been resumed, and the Corporation having submitted to the Commissioners proposals which will meet the objections made by some of the members of the Commission to the former scheme, there is every reason to hope for a satisfactory issue. The volume of the Corporation's business during the year shows a very considerable increase as compared with the corresponding period of previous years, and the factories are at present fully employed. Among the more important and remunerative work that has been done may be mentioned the contracts in connection with the Glasgow, Barcelona, and Melbourne Exhibitions. At the Melbourne Exhibition the Australasian Electric Light and Power Company has installed, besides a large Victoria incandescent plant, about 40 Brush arc dynamos and 1,000 arc lamps. The whole of this plant was supplied by the Corporation, and shipped within a period of two months, and is now in very satisfactory operation in the Antipodes as the largest temporary installation on record. The continental business of the Corporation is also developing very satisfactorily. The factory at Vienna is now a source of revenue, and at Temesvar, where the lighting has hitherto been confined to the streets, the Corporation are putting down extensive plant with a view to supplying the light to private consumers. The theatre and other buildings are already supplied, and the demand for the electric light has very largely increased. In July last the Directors had reason to congratulate the shareholders on the decision of Mr. Justice Kay in the action brought by the Edison and Swan United Electric Light Company, by which judgment was given in favour of the Corporation upon the main issue—viz., the Edison patent, and in favour of the Edison-Swan Company upon the minor issue of the Cheesborough patent. The well-known "Victoria" incandescent lamp, which is manufactured by the Corporation, is absolutely independent of patents other than those held by this Corporation, and is superior to any in the market, either in this country or abroad, in cheapness, durability, and efficiency. In order to cope with the increasing demand, a new factory for the manufacture of these lamps upon a very large scale is being fitted up in the neighbourhood of London. The Directors feel they are able to congratulate the shareholders upon the improved prospects of the electrical industry generally, and having regard to the fact that during the past few years of comparative stagnation, the efforts of the Corporation have been directed to developing its resources for undertaking large contracts, it is now in a very favourable position for profiting by the revival which is at hand.

CITY NOTES.

Eastern Extension Company.—The traffic receipts for the month of September amounted to £41,095, and to £36,400 in the corresponding period of 1887.

Eastern Telegraph Company.—The traffic receipts for the month of September, 1888, amounted to £49,273, against £46,081 in the corresponding period last year.

Western and Brazilian Telegraph Company.—The traffic receipts for the past week, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Company, were £4,359.

Great Northern Telegraph Company.—The receipts for September were £23,400, making from January 1 a total of £202,600, against £197,720 and £195,560 for the corresponding months of 1887 and 1886.

Cuba Submarine Telegraph Company.—The number of messages passing over the lines during September was 3,550, estimated to produce £2,700, against 3,069 messages, producing £2,494, in the corresponding month of last year.

Metropolitan Electric Supply Company.—The shares of the Metropolitan Electric Supply Company, as appearing in the financial papers among unquoted securities, are given as buyers offering ¼ dis.; sellers wanting to sell at par.

Globe Telegraph and Trust Company.—The directors have declared an interim dividend of 3s. per share on the preference shares, less income-tax, and of 1s. per share on the ordinary shares, free of income-tax, for the quarter ending October 18, payable on and after that date.

Reuter's Telegram Company, Limited.—At a board meeting of this Company, held on Wednesday last, Admiral the Right Hon. Sir John C. Dalrymple Hay, Bart., K.C.B., was elected chairman in succession to Colonel Holland, who has retired from the board owing to advanced age.

Brazilian Submarine Telegraph Company.—The accounts of this Company, subject to audit, show a profit sufficient to enable the Directors to recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30 last, and also the payment of a bonus of 2s. per share, both free of income-tax, which together will amount to £32,500, being a distribution in the aggregate of 7 per cent. for the past year, leaving a balance of £34,539. 3s. 7d., of which amount £30,000 has been placed to the reserve fund (increasing that fund to £170,175. 11s. 5d.) and £4,539. 3s. 7d. carried forward.—The traffic receipts of this Company for the week ended October 5 amounted to £5,216.

PROVISIONAL PATENTS, 1888.

JUNE 5, 1888.

8170A. **Electric shunting device.** Herbert John Allison, 52, Chancery-lane, London. (The Baxter Electric Manufacturing and Motor Co., Incorporated, United States.) (Complete specification.) (Note.—This application having been originally included in No. 8,170, dated 5th June, 1888, takes, under Patents Rule 23, that date.)

NOVEMBER 28, 1888.

13,954. **An improved portable electric light apparatus.** Sheard Charlesworth and Joseph Platt Hall, 4, Mansfield-chambers, 17, St. Ann's-square, Manchester.

13,964. **Improvements in the application of portable electrical batteries and incandescent lighting to articles of wearing apparel and other analogous purposes.** Mary McMullin, 8, Quality-Court, London, W.C.

13,965. **A new or improved machine or apparatus for establishing communication between distant points (such as mounting overhead wires over streets, rivers and other places) by means of existing wires, and the like.** Thomas Atkins, 34, Southampton-buildings, London, W.C.)

13,984. **Improvements in electric accumulators.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Middlesex. (Joseph Barbier, France.) (Complete specification.)

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13,987. **Improvement in electric lighting.** Llewellyn Saunderson, 24, Southampton-buildings, London, W.C.

13,994. **Improvements in and relating to cut-out or safety devices for electric circuits.** John Kendall and Owen Cooper, 45, Southampton-buildings, London.

SEPTEMBER 29, 1888.

14,030. **An improved apparatus for generating, graduating the strength of, and distributing electro-magnetic currents for medical and curative applications.** Thomas Barnet Grant, 15, Red Lion-square, Holborn, Middlesex.

OCTOBER 1, 1888.

14,095. **Improvements in and connected with dynamo-electric machines and electric motors.** James Swinburne, Shona, Chelmsford, Essex.

14,110. **Improvements in telephone central-station apparatus.** Theodore Newton Vail, Boston, Massachusetts, and John Ashby Seely, New York, both in United States. (Complete specification.) (Date applied for under Section 103 of the Patents, &c., Act, 1883, 1st March, 1888.)

14,111. **Improvements in telephone-exchange signalling apparatus.** Theodore Newton Vail, Boston, Massachusetts, and John Ashby Seely, New York, both in United States. (Date applied for under Section 103 of the Patents, &c., Act, 1883, 1st March, 1888.)

OCTOBER 2, 1888.

14,129. **Improvements in and relating to dynamo-electric machines.** Henry Harris Lake, 45, Southampton-buildings, London. (Elihu Thomson, United States.) (Complete specification.)

14,149. **Improvements in and connected with dynamo-electric machines and electric motors.** Benjamin Willcox, 47, Lincoln's-inn-fields, London. (Charles S. Bradley, United States.)

14,156. **Improvements in the precipitation and the mechanical, chemical, pneumatic, and electric treatment of towns' sewage, and the utilisation of the solids therein as well as the preparing from towns' refuse a deodorizing and purifying power, which is also applicable for other purposes.** William Young Hardie, 8, Quality-court, Chancery-lane, London.

14,161. **Improvements in the method of producing electro-magnetic inductions for transformers, motors or generators, and in the apparatus therefor.** Louis Bollman, Vienna, Austria, II. Obe re Donaustrasse 93.

14,184. **Improvements in obtaining electricity for electric lighting, motive power, and other purposes.** William Boggett, 34, Southampton-buildings, London, W.C.

OCTOBER 3, 1888.

14,191. **An apparatus for automatically transmitting electric currents.** Sidney Richard Lowcock, Stannington, Church-road, Moseley.

14,226. **Improvements in and relating to continuous current dynamo-electric machines and electro motors.** Robert Dick and Rankin Kennedy, 96, Buchanan-street, Glasgow.

14,230. **Improvements in electricity meters.** John Smith Raworth and William Morris Mordey, 46, Lincoln's-inn-fields, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

OCTOBER 1, 1887.

13,326. **Improvements in machinery or apparatus for producing and administering electric shocks and currents.** John Douglas and Henry Abbott, 1, Sutherland-road, North Bow, E.

NOVEMBER 4, 1887.

15,063. **Improvements in galvanic batteries.** Philippe Skrivanow, 24, Southampton-buildings, London, W.C.

DECEMBER 2, 1887.

16,623. **Improvements in dynamo-electric generators and motors.** Walter Thomas Goolden and Llewellyn Birchall Atkinson, 23, Andalus-road, Clapham, S.W.

DECEMBER 12, 1887.

17,089. **Improvements in the construction of the cores of the armatures of electric motors and dynamo machines.** Moritz Immisch, 52, Chancery-lane, London.

APRIL 11, 1888.

5390. **Improvements in velocipedes and other vechicles propelled by electricity.** John Sherrin and John Vaughan Sherrin, 77, Chancery-lane, London, W.C.

MAY 19, 1888.

7463. **Improved commutator for magneto or dynamo-electric generators.** Maxymilian Kotyra, 22, Southampton-buildings, Chancery-lane, W.C., Middlesex.

SEPTEMBER 4, 1888.

12,761. **Improvements in dynamo electric machines.** Addison G. Waterhouse, 321, High Holborn, W.C.

SPECIFICATIONS PUBLISHED.

1866.

3394. **Generating electricity.** C. and S. A. Varley. (Third edition.) 6d.

1875.

4311. **Electric machines.** A. M. Clark (Bertin.) (Second edition.) 8d.

1885.

12,378. **Galvanic batteries.** A. Schanschieff. (Second edition.) 6d.

1887.

12,437. **Dynamo-electric machines.** R. E. B. Crompton and J. Swinburne. 4d.

12,830. **Electric arc lamps, &c.** W. R. Lake. (Lindemann.) 8d.

12,924. **Incandescent electric lamps, &c.** G. Zanni. 8d.

14,783. **Mariners' compass.** J. C. Dobbie. 8d.

15,754. **Secondary voltaic batteries.** W. J. S. Barber-Starkey. 6d.

1888.

2516. **Measuring the intensity of a magnetic field.** G. Miot. 8d

9991. **Magneto-electric apparatus.** W. R. Lake. (Humans.) 8d.

10,954. **Dynamo-electric machines.** E. H. Geist. 6d.

11,338. **Telephone line circuits.** L. Kelner. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	3⅝
12 Feb.	2/0	— fully paid	5	4⅝
27 July	1%	Anglo-American	100	48½
27 July	2%	— Pref.	100	81
12 Feb., 85	5/0	— Def.	100	17
28 June	3/0	Brazilian Submarine	10	13¼
14 June	1/0	Con Telephone & Main	1	⅝
10 Aug.	9/0	Cuba	10	13¾x
10 Aug.	10/0	— 10% Pref.	10	18½
28 Mar.	2/2½	Direct Spanish	5	4⅛
28 Mar.	5/0	— 10% Pref.	5	10¼
27 July	2/0	Direct United States	20	10¼
27 July	4/6	Eastern	10	12½
27 July	3/0	— 6% Pref.	10	15
1 Aug.	5%	— 5%, 1899	100	110
26 April	4%	— 4% Deb. Stock	100	110
12 July	2/6	Eastern Extension, Australasia & China	10	13 1/16
1 Aug.	6%	— 6% Deb., 1891	100	104½
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	103
28 Mar.	8/3	German Union	10	9⅛
10 Aug.	3/0	Globe Telegraph Trust	10	7¼
10 Aug.	3/0	— 6% Pref.	10	14¼
30 April	5/0	Great Northern	10	14
1 March	5%	Gt. Northern 5% Deb., '83.	100	109
27 July	10/0	India Rubber, G. P. & Tel.	10	17 1/16
11 May	37/6	Indo-European	25	39
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
		Swan United	3½	2¼
10 Aug.	13½%	Submarine	100	140x
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	99
12 July	4/0	West Coast of America	10	8
30 June	8%	— 8% Debs.	100	115
11 May	9/0	Western and Brazilian	15	12½
11 May	6/10½	— Preferred	7½	7¼
11 May	2/1½	— Deferred	7½	5½
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	1⅛
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80		— 6% 2nd Pref.	10	10⅜
2 May	7%	West Union of U.S.	$1,000	125
1 Mar.	6%	— 6% Sterling	100	102

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NOTES.

Sprague Railways.—The Sprague Company have started another electric railroad successfully at Hartford, Connecticut.

Monte Carlo.—The electric light will be substituted this winter for gas in the gardens and in the Casino at Monte Carlo.

Battery System.—An installation for 10,000 lights has been organised at St. Louis, to be worked on the storage battery system.

Harrow.—Last week a meeting of the ratepayers of Harrow was held to consider the advisability of adopting electric lighting in the town. After some discussion, it was resolved to ask the Local Board to investigate the matter.

Central Station.—The site for a new central station for the Metropolitan Electric Supply Company has been secured on the south side of Waterloo Bridge, near Mr. Seth Taylor's flour mills.

Welding Machines.—The Thomson-Houston Electric Welding Company are erecting a large and commodious factory at Lynn, Massachussetts, for manufacturing the welding machines in large quantities.

Sir John Pender.—Sir John Pender has been presented with the freedom of the burgh of Dingwall in recognition of his services to the county in connection with the extension of submarine telegraphy throughout the world.

Metalli-Floral Electroliers.—Some very pretty and tasteful fittings are being introduced in light twisted copper work, in naturalistic floral patterns, for electric fittings, by Messrs. Lea, Sons, and Co., of Chester-street, Shrewsbury.

Quick Work.—An installation at Philadelphia for 100 incandescents, 10 arc lights, an elevator motor, and 120 sewing-machine motors is said to have been completed after eight on Friday evening for starting on the following Monday morning.

Camel Hair Belts.—Driving belts made of camels' hair are recommended by the Polytechnic Institute of Munich, as being strong, noiseless in running, and not affected by acids. We are not aware whether the suggestion has been practically adopted by belt manufacturers.

Translation.—What funny mistakes our foreign technical contemporaries make when they get hold of an English name unknown to them. One would hardly recognise under the cognomen of "MM. Pans et Schott, de Newcastle,' our friends Messrs. Paris and Scott, of Norwich.

Electric Executioner.—The New York *Electrical Engineer* facetiously suggests that the American Legislature, in view of the recent discussion, and to satisfy Harold P. Brown, should make him Lord High Executioner, the office to continue during life, or good conduct! Poor Harold P.

Electric Motor in Railway Works.—An electric motor, guaranteed to move weights of 100,000 pounds at a rate of 300 feet per minute, is to be employed on a "transfer table" in the works of the Pennsylvania Railroad at Altoona. The motor and gearing will be supplied by the Sprague Company.

Electric Railway for Morecambe.—The Local Board of Morecambe have considered the plans of a new electric railway proposed to be made between Lancaster and Morecambe, and unanimously agreed to give their consent to the tramway company for an application for a provisional order authorising the construction.

Tariff on Books and Apparatus.—At the last meeting of the American Association for the Advancement of Science, a petition to Congress was adopted to place on the free import list books pertaining to physical, natural, and medical science; and also apparatus intended for purposes of scientific research or education.

Physical Society, Glasgow.—At the next meeting of this society, to be held October 26th, Mr. G. G. Henderson, M A., will read a paper, entitled "Determination of Molecular Weights"; and at the following meeting, November 9th, a paper on "Magnetic Leakage" will be contributed by M. A. Tanakadate, B.Sc. (Japan).

More Light Wanted.— Mr. Dickens, speaking at the St. James', Westminster, Vestry, said that he had lately been in Germany, and did not hesitate to say that in any second-class city in Germany the lighting was superior to anything that could be found in the metropolis. London, as a city, was very badly lighted, and St. James', Westminster, was about the worst-lighted portion of it.

The Waterhouse System.—We learn that the Waterhouse Electrical Company have been awarded the two diplomas and the gold medal at the recent Cincinnati State Exhibition. The regulation of the Waterhouse dynamo was illustrated in our last week's issue; the dynamo itself in our issue of June 1. The system is in the hands of Messrs. Shippey Bros. for England and France.

Country House Lighting.—The electric light is every day becoming more general in country mansions. One of the latest additions to the list is the residence of Mr. Sydney Courtauld, at Braintree, which has been lit by Messrs. Drake and Gorham. The Benson fittings show to great advantage in the large hall, and the special scroll-work pendants by Faraday and Son are also much admired. Mr. Courtauld had made a previous trial of the light in his old house, where it worked for some years without any hitch or failure.

Electricity in the Blacksmith's Shop.—An easy and novel means of testing the condition of horses' feet is suggested by Mr. J. C. Henry in the *Scientific American*. Take a battery or magneto machine, one that gives a light current, say such as can only be felt with moist hands. Attach one terminal to the animal's bit, the other to the shoe. If the horse suffers from the shoe or nails, he will squirm under the test. If there is no irritation, it will pay no attention to it. A little electrical science in the blacksmith's shop would detect much suffering.

Shoal Water Indicator.—An electrical device for indicating shallow water and for taking soundings has been invented by Messrs. Vigil and Resueltas, of Providencia-street, city of Mexico. A can filled with lead shot has an insulating tube inside it, half filled with mercury. The can is dropped into the water by a sounding line, and, as long as it is in deep water, the mercury remains at the bottom of the tube, but on touching bottom the can is tipped, the mercury flows along the tube, making electrical contact, and an alarm bell is rung on board the vessel.

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Madrid.—The Opera House at Madrid has the largest single installation in Spain. The lighting comprises 2,800 incandescent lamps, and six arc lamps will be used on the exterior of the building. The installation has been carried out by the Matritense Company, and consists of three Babcock and Wilcox boilers, and four dynamos coupled direct to engines of 60 h.p., supplied by the Oerlikon Works, of Zurich. The dynamos before used by this company have been Gramme dynamos, made at Barcelona; but the Oerlikon Works secured this order by undertaking the contract for delivery in six weeks.

Combination Cigar-Lighter.—An electric cigar-lighter is being made by the London Battery Company, 132, Southwark, with an ingenious combination of services. A square box contains the battery, an induction coil, and the magnet of a bell. Through the centre of the bell a piece of wick from a spirit lamp projects, and a sparking point nearly touches the wick. This is lighted by the act of cutting off the cigar end, which also makes contact with the coil, and an induction spark passes to the wick. Spirit tapers are placed alongside to convey lights to the cigars, and a press button rings the electric bell to call the waiter.

Novel Earth-Plate.—Signor Baretta has invented a new earth-plate, which consists of a sheet of corrugated copper or iron rolled in the form of a cylinder, about 30in. diameter, and the same in height. The corrugations are furnished on the interior and exterior with conical points of copper, and the free edges of the plate are cut in zigzag teeth. A large surface of contact with the soil is thus obtained. In dry and rocky places a 5ft. trench is dug, and a first sheet of corrugated copper is laid horizontally upon a layer of small coke; another layer of coke and a second plate is laid on this, and the two plates are connected together. A third layer of coke is placed on top, and the whole filled up with earth.

Propeller Screws.—In view of the probable increase of electric launches, some experiments, with the object of increasing the speed of screw steamers recently made in Italy, will be interesting. A vessel already fitted with twin screws had a further small screw placed to revolve below the other two in a triangular position therewith. The increase of fully a third in speed was accomplished, due, it is thought, to the much greater resistance of the water at some little distance below the water already agitated by the other screws. The addition of a third in speed seems a very important increase, especially as it is well known an increase of speed at an already high rate of speed is difficult of attainment, and possibly the method suggested may prove of considerable service in the construction of screw vessels.

Business.—From all sides we hear of work increasing. Messrs. J. H. Holmes and Co., of Newcastle, have orders sufficient to last till Christmas. They are lighting, amongst others, six large ships, and have orders in hand for two dynamos of 1,100 lights each for a central station. Messrs. Willans and Robinson are so busy with their engines that they cannot promise delivery before March, and are actually obliged to refuse orders. Crompton's are very busy, both with lighting and with smelting dynamos. Switch and fitting makers are up to their ears in many cases. The Brush Company are building a new incandescent lamp factory. Verity's are doubling their premises, and the Acme Works are hard at it with Cockburn's switches and cut-outs. Callender's have their hands full with wire and cables, and so on with other firms.

Sunbeam Lamps.—The high candle-power incandescent lamps known by the name of Sunbeam lamps, are extending in use in various directions for situations hitherto monopolised by the arc lamp, as, in spite of the greater current used, the low first cost and absence of necessity for cleaning and carbons render them preferable in many cases. Many installations include one or two of these lamps among the smaller with good effect, and several hotels in London have adopted them for use for exterior illumination. The Café Monico has used them for some time. The Langham Hotel has also had sunbeam lamps fixed at the sides and entrance, providing an excellent light without too much glare for the hotel entrance; and the Hotel Victoria has a beautiful illumination at its entrance from a 200 candle-power lamp.

An Attractive Moter Scheme.—A "new motor for tramcars" is described by the *Pittsburgh Gazette* as a brass tube laid between the tracks, through which plugs or cylinders of iron are forced by pneumatic pressure at intervals of one-half minute or less. Under the car is to be a long bar with a flat piece of iron on the end, on which is an electrical battery, strong enough to magnetise the iron sufficiently to form a grip to the moving plug in the brass tube; brass being chosen because it is a good conductor of electricity, but is not magnetised. When the car is to be started, the battery is set in operation, and the magnetised bar draws the car with the iron plug it is nearest to, and on stopping the flow of current from the battery the car stops. The scheme is decidedly novel—in fact, quite a flight of genius, but cannot be said to be "sufficiently attractive."

Portable Installation for Cologne.—A carriage has been constructed for the town of Cologne on the plans of Mr. Hegener, director of the water and gas service, fitted with apparatus for the production of the electric light. This carriage is intended for the lighting of night work, for lighting the streets in case of accident, and, in fact, in all cases where a powerful light is required on any emergency, as is often the case in large towns. The carriage is fitted with a boiler, dynamo, 400 yards of conducting wire, and four arc lamps fitted with posts. There is also a high candle-power incandescent lamp for carrying about where an arc lamp could not be used. On arrival at the place required, the posts are fixed upon the ground, the lamps are suspended and the current turned on—an operation only requiring a few minutes to perform. This portable installation has been constructed by the assistance of the Helios Company at a cost of £700 inclusive.

Electro-Magnetic Telephone.—Prof. R. B. Fulton, of the University of Mississippi, has given in a recent paper a description of a novel form of electro-magnetic telephone of his own design, in which the ordinary spool electro-magnet and circular diaphragm are replaced by a magnetised tube of thin sheet iron, with the insulated wire wound around the tube. The tube has a rectangular cross section about 2in. square (it may be of any length), and open at one or both ends. It is magnetised by steel magnets, or a current, so as to have the lines of force running parallel to its length. The wire is coiled around those parts of the tube which form vibrating segments when vocal or other sounds are made near an open end of the tube. The lines of magnetic force, the direction of the vibratory motion of the walls of the tube and the direction of the induced currents are thus each at right angles to the

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other two. The instrument may be used either as a receiver or transmitter, but seems to work best as a transmitter to a Bell receiver.

St. James' Vestry.—The Lighting Committee recommended, in answer to an application on behalf of the Metropolitan Electric Supply Company, Limited, for consent to apply to the Board of Trade for a license under the Electric Lighting Acts, that the vestry are not prepared to assent to a license in the form submitted by them; but, with a view to expedite the commencement of operations, they would be disposed to consent to an application for a license in the form of the South Metropolitan Electric Lighting Order, 1888, which is awaiting comfirmation by Parliament. Also that the solicitors of the London Electric Supply Corporation, Limited, be informed, in reply to their application for consent to apply to the Board of Trade for a license under the Electric Lighting Acts, that the vestry have already consented to the establishment of two electric lighting installations in this parish, and that they are not prepared to assent to any further license or provisional order until these installations are either fully at work or have been abandoned.

A Natural Battery.—An instance is given by A. A. Knudsen, in the *Electrical World*, of a telephone line built this summer at Bridgewater, Nova Scotia, running to the gold-mining district some thirty miles distant. When the line was finished, a steady current of electricity was found flowing over it. The fault was found to be near the gold-mine end, and he attributes the current to the natural battery formed by the gold mine with the other mineral deposits—copper, silver, lead, and iron—in the vicinity. The copper, silver, or lead ores, he thinks, either together or separately would form the negative, and the iron the positive, the earth and rocks being the porous cell, and the water and moisture completing the huge galvanic battery. The current, of course, if such is the case, is always on short circuit, only a small portion showing itself on the wire. The current is always stronger on rainy days, which agrees with this theory. It is not sufficient to cause a total interruption, but repetitions are often necessary to get the bell to ring. There is no trouble in talking.

Lowrie-Hall System.—At Eastbourne the electric lighting is worked entirely upon the Lowrie-Hall system; all the consumers have converters and meters upon their own premises, and the supply has proved very satisfactory. Brighton is being adapted to the same system, about half the supply having been altered. The Lowrie-Hall regulator used in this system, which we illustrated recently, is extremely sensitive, regulating the difference of potential to within one volt. It is equally adapted to continuous as to alternating currents, as the regulation depends upon the lengthening effect of increased heat in a long thin wire. Briefly, the action is thus: The sag in the long stretched wire tips one way or the other a delicate balance-arm with platinum tips to which it is connected, and the current one way acts upon a solenoid to put in resistance in the field of exciter, and to decrease the resistance the other way. Besides the new station at West Brompton, a station will be shortly established at Headingley, near Leeds, on this system by the Headingley Electric Light Company, and a station will probably be also opened in the north of London.

Electric Recutting of Files.—A novel method of recutting old files by electricity has been described by M. Robert Personne, of Sennevoy, in a letter addressed to *Le Genie Civil*. This method, in which it is not necessary to retemper the steel, consists in forming a battery of carbon and acidulated water, in which the file replaces the zinc plate and plays the part of negative element. The file, previously cleaned, in placed in acidulated water between two plates of carbon, and a circuit is established by a closed circuit between the carbons and the file by means of a piece of metal, which also serves as support. The hydrogen liberated by the action of the current, owing to a little known law of attraction, remains attached to each tooth of the file, protecting it against further action of the liquid, but the cutting action freely proceeds over the remainder of the file. The protective action of this "veritable gaseous coat of mail" is clearly seen on examining a well-worn file, half of which has been recut in this manner. This process, which speedily renders the teeth of an old file of their original and normal dimensions, is not a simple sharpening, but constitutes a real recutting, and one, moreover, which does not necessitate either softening or subsequent retempering.

Paddington Vestry.—The Electric Lighting Committee recommended, "That they are of opinion that, after full consideration of the Electric Lighting Acts, and the rules thereunder, and having considered the report of Mr. Mackie, and the various notices and applications from electric lighting companies, the vestry will be best studying the interests of the parishioners and inhabitants of Paddington by at once taking the necessary steps to apply this year for a provisional order or license. That the vestry oppose the granting of all applications for provisional orders or licenses which may be made by any public companies, and that the solicitor be instructed accordingly." Mr. Mark Judge objected to this, and proposed that they should not yet apply for a provisional order, but ask the Board of Trade whether they would consent to dispense with any application for a license or provisional order during the present year, and in the meantime he would oppose all applications of companies, &c., pending the decision of the vestry. He moved as an amendment that the whole question of electric lighting, together with the reply of the Board of Trade, be referred to the Electric Lighting Joint Committee for consideration and report. This was seconded, and was carried by 15 to 13.

Opalescent Screens.—An idea in effective use of incandescent lamps for artistic effect is given in the *New York Electrical Review*, the device of Mr. Steele Mackaye, the dramatist, who, with only a dim idea of the possibilities of the little incandescent lamp, but with the true artist's instincts withal, came nearer to the ideal than many of the glass artisans with all their vaunted art. It was several several years ago, and the decorators were at work in the then new Lyceum Theatre in Fourth-avenue. They were not getting the effects with the incandescent light he had hoped for, and, thinking of the matter overnight, he, with the originality that belongs to him, hit upon a promising idea. Early one morning he went down to Fulton Market and bought some bull's bladders—he never explained why cow's, or sheep's, or goat's bladders would not do—and these, cut up in small squares, he had stretched across the little lights sunk into the walls and ceilings with delicate-coloured glass between. The result was surprising, for when night was come opalescent lights, of white, and bluish, and yellowish white, shone down, with all the delicate tints of blue and green and yellow and red that is thrown out through the fissures of the noble opal.

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Electric Power in the Comstock Mines.—The Brush Electric Company, according to *The Mining Industry*, has shipped to the Nevada mill two dynamos and motors of an improved pattern, that will be able to put upon the stamps 80 per cent. of the power generated at the bottom of the shaft. There are to be six dynamos, one always to be held in reserve, and six Pelton wheels 40in. in diameter, to be made of phosphor bronze, to drive them, each attached to the dynamo shaft direct. These wheels will be set up at the tunnel level of the mine, in a large chamber already prepared to receive them. A column of water brought down the side of Mount Davidson in a wrought-iron pipe will be delivered through a proper nozzle upon the surface of the wheel which stands in the mill, under a perpendicular pressure of about 460ft. This wheel is 10ft. 10in. in diameter. After the water leaves the wheel it is piped to the main shaft of the Chollar mine. Down this shaft (and the incline at its bottom) the water is conveyed in two pipes to the electric chamber on the tunnel level. The water will be put upon six wheels under a perpendicular pressure of 1,630ft. In no place in the world has water been used on a wheel under such a tremendous head. The water will be delivered upon each wheel through a nozzle somewhat less than half an inch in diameter. Each wheel is intended to develop about 125 h.p. This will make a total of some 750 h.p. delivered by the six wheels. The fact that this is the first attempt in the history of mechanics to operate water wheels under such an enormous pressure, as well as the fact of the utilisation of the power by electrical transmission, will cause the result of the experiment to be everywhere anxiously awaited.

Instantaneous Boiler.—M. Georges Lesourd, in *Le Genie Civil*, describes a novel boiler for instantaneous steam generation, the invention of MM. Serpollet Frères. In this boiler the sudden evaporation of small quantities of water between two heated metallic surfaces placed close together is utilised for generation of steam power for small engines. The boiler consists in essence of a long stout copper tube, which has been passed through rollers while hot until the sides are pressed together with only a capillary space between. This long flat tube is then coiled in three convolutions inside a furnace space, where they can be heated to a high temperature. The outer end of the copper tube remains still circular in section, and through this tube, heated to 600deg. F., water is injected, turning immediately to steam. The cubical contents of the capillary aperture being small, the force of the steam in case of rupture would be harmless. There are no tubes, rivets or joints to get out of order, and the utmost simplicity and security is obtained. The boilers are not made at present over two h.p., though the same principle might be applied to greater powers, and the usual size made is one h.p. This is about equal to the size of an ordinary stove, being 16in. diameter, and about 2ft. high, and weighing 245lb.; it has been used for running small tools, pumps, &c., and could be used for dynamos for small installations of six or eight lamps. The tube for this size before flattening is 2in. diameter, $\frac{7}{16}$in. thick, and 6ft. 6in. long. If this steam generator proves entirely satisfactory and practical, there is evidently a wide field of usefulness before it; for a small, simple, and secure steam boiler for use with small engines, one, moreover, which can be used with mineral oil if desired, is a very great desideratum. It is intended to fit up one horse boilers with engine and dynamo on the same bed-plate.

Spectroscopic Telegraphy.—The invention of Mr. Paul La Cour, by which optical telegraphic signals are transmitted by means of spectroscope, is attracting a great deal of attention at the Copenhagen Exhibition. Telegraphic despatches by long and short flashes have been long adopted, but in the spectro-telegraph the transmitting ray itself is broken up by means of suitable apparatus into luminous or dark bands instead of the continuous spectrum of ordinary white light. These bands are arranged to form telegraphic signals, and can be read off by a Morse operator in the receiving glass. As it is the composition of the whole ray of light itself that is affected, and not a visual image that is transmitted, the size of the receiving signals is not altered by a greater distance, though, of course, they are feebler with the same light. The strength of the light, however, can be reinforced. It is well known that ordinary white light, when passed through coloured glass and thus deprived of some of its colour rays, is broken up into dark bands if passed through a refracting prism. In the despatching lantern of the spectro-telegraph is a screen with openings corresponding to telegraphic characters, and by an ingenious combination in the lantern these characters change position by the turning of a handle at the same time with the light-changing apparatus. The receiving glass is fitted with suitable prisms, and the characters pass continuously before the eye of the receiver as a luminous telegraphic scroll. The characters can, of course, be arranged to correspond with the ship code of signals, or can be used for actual transmission of telegraphic messages. These could be sent from lighthouses along the beam of light to ships at sea during the night-time, and could also be adapted to a ship's mast-head light to afford information of direction of bearing, &c., to other ships, and, in fact, to telegraph all kinds of actual messages. The invention will, doubtless, have very valuable practical applications in marine navigation.

West Brompton Central Station.—The central station, on the Lowrie-Hall system, being installed at West Brompton by the House-to-House Electric Supply Company is being rapidly pushed forward. About 150 men are actively engaged on the work, the boilers are in situation, and the heavy parts of the engines are delivered. The dynamos—which are on the Lowrie-Parker patent, and made by Elwell-Parker, of Wolverhampton—are ready, and are waiting at Wolverhampton for the completion of the building to be delivered. The work is, under contract, to be completed and running by the 15th November, but various other delays in the nature of consents of vestries will probably delay the opening a little. The circulars of the company therefore announce the supply to commence on December 15th. The scheme is being well taken up in the neighbourhood. Already over 3,000 lights have been ordered, and further orders are being received every day. The station will be worked entirely on the Lowrie-Hall system, as now in use at Eastbourne, with Lowrie-Hall converters, potential regulator, and differential depositing meter. The plant consists of three Babcock and Wilcox boilers, each capable of steaming for 2,000 lights; three Fowler engines, and three 2,000-light dynamos. These will be all interchangeable, and the capacity of the plant will be increased up to twelve similar 2,000-light sets as the demand increases. The charge for current will be regulated on a sliding scale, varying with the maximum supply demanded by the householder, as follows: (1) At the rate of 1s. per Board of Trade unit for the first 100 hours' consumption of the maximum supply demanded; (2) at the rate of 8d. per

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Board of Trade unit for the second 100 hours' consumption of the maximum supply demanded; (3) at the rate of 4d. per Board of Trade unit for any further quantity consumed. The rent of meter, instruments, &c., will be charged at 5s. per Board of Trade unit of maximum supply demanded per quarter.

Institution of Civil Engineers.—The Council of the Institution of Civil Engineers have circulated a list of subjects for original papers. The list is not meant to be exhaustive, but suggestive, and premiums will be awarded to approved papers. From this list the following are allied to electrical industries: The Utilisation of Unused Sources of Power in Nature, such as Tides, the Radiant Heat of the Sun, &c.; Standard Specifications for Materials used in Construction of Engineering Works; Descriptions of Mining Machinery of improved design; Gold-quartz Reduction and Amalgamation—description of the various machines, and of their method of working; the Present Position of the Manufacture of Steel—its defects, and suggestions for its improvement; the Effect upon Basic Steel of (*a*) Chromium, (*b*) Aluminium, and (*c*) Tungsten; the Properties of Bronzes and other Alloys; the Corrosion of Metal Structures, and the best means of preserving them; the Effect of Wind upon Structures, as influenced by (*a*) their superficial area, (*b*) the form or position of the exposed surfaces, (*c*) the shelter of adjacent bodies, and (*d*) the dynamic action of sudden gusts; the Construction of the Working Parts of Steam-Engines in relation to the high pressures and temperatures now becoming general; the Various Systems of Forced Draught in Boilers, with the economical results obtained; on Modern Experience in Screw Propulsion, comprising the comparative efficiency of propellers of large diameter, and of smaller ones deeply immersed, and of the influence of form; on the Highest Speeds attained and attainable on Railways, having reference to gradients, curves, and the locomotives employed; the Application of the Compound Principle to Locomotive and to Portable Engines; Mechanical Traction on Common Roads; the Petroleum Engine and its Applications; Hydraulic Rotative Motors for High Pressures; the Means of Governing and Economising High-pressure fluid in Hydraulic Cranes, Engines, &c.; the Construction and Working of Windmills; the best Combined System of Warming, Ventilating and Lighting Large Buildings; the Plant used in the execution of important Engineering Works; the Construction and Working of Friction-Brake Dynamometers; the Generation of Alternating Currents in Dynamo Electric Machines, and their utilisation for Lighting and Power Purposes; Electric Meters for recording the Consumption of Electrical Energy; the Construction and Maintenance of Secondary Batteries; Central Station Electric Lighting; the Application of Electricity to the Working of Street Tramways and of Railways; the Application of Electricity to the Working of Cranes, Pumps, Tools, &c.; the Application of Electricity to Smelting and Metallurgical Operations; the Application of Electricity to the Purification of Water and of Sewage; the Purification of Copper, and the Reduction of Copper Ores by Electrolytic Processes; Contributions to the Bibliography of special branches of Engineering.

The New Burg Theatre.—The new Burg Theatre at Vienna, opened on Sunday last, is a marvel of decorative, artistic, and scientific skill, and is probably the most costly playhouse ever constructed. The cost is said to be as much as 30,000,000 florins, which expense is borne by the Emperor of Austria. The interior decoration is of the most magnificent description, aided by the beauty of the electric light, and in reality only rendered possible by the security from dirt which this assures. Frescoes, statuary, and rare specimens of tapestry embellish the walls, and an exquisite combination of variegated marbles and mosaics constitute the balustrades. The chief objects that attract the eye at the moment of crossing the threshold are the superb bronze lustres for electric light, and the richly-gilded wrought-iron gates. The windows of the entrance-hall are of majestic proportions. On the landings are divans and ottomans, covered with rich tapestry of chaste designs. The staircase is of San Stefano marble of yellow hue, carpeted with crimson drugget. Plastic ornamentation is conspicuous everywhere. The Court boxes are hung with priceless tapestry of delicate hues, corresponding in colour with the paper, hangings, and upholstery of the public boxes, which are white, gold, and dark red. Admirably executed mural and ceiling pictures are to be found in every part of the house. Two vast staircases of palatial magnificence, ascending without any turn to the level of the first floor, give access to the boxes right and left of the house. The doors are so many, and so wide, that no panic could produce a crush, and the audience would disperse itself easily through the vast *foyers*, and find its way to the doors of exit. The architect, Baron Hasenauer, has taken every possible precaution against the destruction by fire of so much that is costly and beautiful, and the fixtures of the interior are chiefly of iron. The ventilation of the whole building is perfect, the air passing gently through gratings under every seat in the pit. The lighting of the new Burg Theatre will be entirely by electricity, and its installation is the most complete and substantial theatre installation ever carried out. The current will be supplied on the battery transformer system. The accumulators are situated in the cellars of the theatre, and are charged from the central station recently erected by the Imperial Continental Gas Association. The accumulators are of local manufacture, having been supplied by the Austrian licensees of the Electrical Power Storage Company. From the accumulators the current is conveyed to massive switch-boards, and thence through meters to the distributing room. In this room are placed switches and automatic cut-outs governing the whole of the circuits going out to every part of the house, so that any portion of it can be lighted up or put in darkness as required. The total number of lamps in the house is considerably over 5,000, varying in power from 10 to 40 c.p. Outside, the approaches are lighted by means of ten arc lamps. On the stage, where there are 2,100 lamps of 25 c.p. each, the lighting is very brilliant. An elaborate system of regulation has been introduced for the purpose of obtaining the most varied scenic effects. The different colours will be produced by means of coloured lamps, the coloured mediums such as have been used hitherto for this purpose being entirely abolished. The fittings throughout the house are not, perhaps, as suitable as could have been desired, many having been designed, years ago, for gas, before it was decided to adopt the electric light. The large electrolier in the auditorium is, however, an exception, and is a light and elegant piece of workmanship. Throughout the house the cables and wires have either been protected by lead coverings or have been laid in wood casing. Every possible precaution has been taken to avoid trouble in the future working. The insulation resistance of the whole has been repeatedly tested, and has always been found most satisfactory

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NOTES ON CHOOSING AND INSTALLING ELECTRIC LIGHT PLANT.

BY L. A. DAVIES, A.S.T.E. AND E.

It is not the intention of the writer of this article to more than lightly touch upon the many points which come under the above heading, and he would commence by saying that all he aims at is to be of some assistance to any one who may be intending to adopt the electric light as an illuminant, and who is not possessed of technical knowledge or experience. Electric lighting has been before the public for a good many years now, but complete ignorance of its most elementary principles is still the rule rather than the exception. About five or six years ago electric lighting made a sudden and rapid stride into public notoriety, and it was confidently believed that all practical difficulties till then opposing its progress had been overcome, and that nothing remained to be done but to push on one side all the existing illuminating agents and to install the new light. It is not necessary to recall to the readers of the *Electrical Engineer* how companies were formed and patents bought at exorbitant prices on the mere word of the inventors, and without any of the tests which would have so easily exposed their commercial worthlessness. The public paid for its folly, but they were by no means the only sufferers, as the reputation of the whole electrical engineering profession was to a great extent "blown upon," and the natural growth of legitimate business stunted through the unscrupulous gulling of the public by reckless "promoters."

It has, no doubt, come to be believed by people not behind the scenes that electric lighting from a commercial point of view is impracticable, but no greater proof of the innate vitality of the electric lighting industry could be needed than is afforded by the fact that it is at the present moment in a sounder and more economically successful condition at the present moment than ever it was before. Old apparatus have been perfected and new appliances devised. If carried out on a scale commensurate with that of gas, electricity can be supplied for lighting or motive purposes more cheaply and without risk of break-down or stoppage. It is frequently said that "the electric light is so uncertain, and liable to go out suddenly." Here we have another legacy from the speculators who, having taken their unfortunate shareholders' money, found themselves obliged to take work at any sort of price, and consequently put in the cheapest and most worthless materials and workmanship, so as to secure the barest margin of profit, and be enabled to make a pretence of paying a dividend! This practice by no means ceased with the collapse of the bubble companies. The general public are, of course, unable to tell good workmanship and materials from bad. For them "the proof of the pudding is in the eating," and there are still many unscrupulous people in the profession who do not hesitate to take advantage of this fact, and undersell respectable firms who conscientiously decline to forfeit their good name by selling anything but good material at a fair price. This sort of thing will, no doubt, continue until users of electrical machinery take the trouble to obtain a little more knowledge of the principles of electrical engineering. This article, it is hoped, will assist a little in the diffusion of such knowledge.

We will now proceed to consider the lines upon which a decision should be come to as to the best method of adapting the electric light to the requirements of any building or locality. The plan adopted by many persons is simply to send a few meagre particulars, and, perhaps, a more or less inaccurate sketch of the premises to some firm undertaking installation work, and then trust to Providence and the firm for a satisfactory result. If the firm applied to is conscientious and skilful, the result may be satisfactory; if not, trouble follows as a natural consequence. In either case, the plan is a very expensive one, and it is high time for people to begin to understand how to rough out an intelligible specification for themselves of any electrical work they may want done.

In the first place, it must be decided whether the proposed lighting is to be effected by means of arc or incandescent lamps, or a combination of the two. It is now pretty well agreed that the proper place for arc lamps is out of doors, and that of incandescent, or glow lamps, indoors. Of course, there are exceptions to this rule as to any other. Large halls and railway stations may be very suitably lit by means of arc lamps; and, again, it would not pay to light up a small courtyard with 2,000 c.p. These exceptions are, however, few, and are now to a great extent provided for by the recent introduction of the "Sunbeam" and other incandescent lamps of high candle-power. Glow lamps are usually of either 8 c.p. or 16 c.p. An 8-c.p. lamp will light up a space of 8ft. radius quite sufficiently for any ordinary purpose. One 16-c.p. lamp should be allotted to every 144 square feet. A 2,000-c.p. arc lamp will suffice for a space of 60ft. radius, and should be fixed at a height of from 20ft. to 30ft. above the ground. A 3,000-c.p. lamp will illuminate a space of from 90ft. to 100ft. radius, and should be fixed at a height of 40ft. to 50ft.

Incandescent lamps are almost always connected in parallel. Arc lamps may be connected in either series or parallel. A series arrangement presents the advantage of a simple system of leads and consequent saving of first cost, but it entails the drawback of using a current of high E.M.F., and necessitates great care in handling any portion of the circuit when the current is flowing. In experienced hands, however, there is no great danger of accident from this cause. Arc lamps can also be run in parallel, and this arrangement has also special advantages and drawbacks. One great advantage is the entire immunity from accident secured by using a large current, but small potential. This need never be higher than 60 or 70 volts across any two points in the circuit, and an E.M.F. of so low a value is perfectly harmless. When connected in parallel, moreover, any number of lights can be switched off without producing any effect on the remainder, and with a proportionate saving in motive power and fuel. It is found also by experience that a much whiter light is obtained from lamps using a current of low E.M.F. The disadvantage of the system is that a larger amount of copper is necessary in the leads, but they need not be expensively insulated as in the case of series lamps.

Incandescent lamps may be served with an alternating or a continuous current. The life of the filament will be appreciably greater when used with an alternating current, owing to the more equally distributed disintegration of the carbon. Some arc lamps will also burn with an alternating current, but a better and purer light is afforded by a continuous current lamp by reason of the better definition of the crater formed in the positive carbon.

The style of dynamo to be used may be next considered. The decision on this very important point will have been predetermined to a certain extent by the choice made of the system of wiring to be adopted. If the lamps are to be connected in series, we must employ a series dynamo giving the necessary high E.M.F. and small current, but if the installation is to consist of incandescent lamps or arc lamps in parallel, or a combination of the two, a shunt or compound-wound dynamo must be provided to generate a large current of low E.M.F. Shunt and compound machines give much less trouble in working than high-tension series dynamos, owing to the absence of sparking and non-liability to breakdowns in the internal insulation.

Alternating machines are usually adopted only when it is desired to convey a current a considerable distance, and further mention will be found of these dynamos when the transformer system is under consideration.

(To be continued.)

ON THE ELECTRICAL RELATIONS OF TELEPHONE AND ELECTRIC LIGHT AND POWER CIRCUITS AND RAILWAYS.*

BY T. D. LOCKWOOD.

This paper deals altogether with the disturbing effects of electric light and power currents upon telephone lines, and not at all with the dangers of imperfect construction and insulation; nor with the results and prevention of dynamo current crosses, there being sufficient in the latter branches

* Paper read before the National Telephone Association, New York.

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of the subject for a separate and equally voluminous paper. It will consequently be assumed for the purposes of this paper that the important precaution of effectively insulating wires conducting heavy currents is observed, and that "undertaker's wire" is, as it ought to be, a thing of the past.

The telephone exchange business was commercially organised and established in the first months of 1878. Electric lighting, as a commercial industry, had its beginnings in 1878 and 1879, but did not at first take root with the same degree of rapidity which characterised the exploitation of the telephone, and not until some years thereafter did it achieve popularity.

Consequently the telephone systems obtained considerable start, and were firmly established in nearly every city and town in the country before the organisation of many electric lighting systems. It was not at the outset generally known that the telephone circuits would be annoyed by the presence and proximity of parallel electric light wires, and telephone companies were thus at first most liberal in permitting the erection near their lines of foreign lines carrying heavy and widely-fluctuating currents. Yet a little thought and consideration would have laid bare this danger. We knew that the telephone current was itself of most shadowy and almost intangible character in point of strength, and that to utilise it such a super-sensitive instrument as we all know the telephone to be was actually essential. And we knew that *because* the telephone receiver was such a delicate electroscope, and so sensitive to electric motion, we had heretofore been much annoyed by mutual telephone induction, by telegraphic induction, and by miscellaneous induction. So, as I say, if we had carefully considered the matter, we might have foreseen the full extent of the electric light disturbance which is now being sustained.

But we did not foresee, and as a result of our lack of foresight indiscriminate contruction has ensued; and in consequence of improper construction the business of many telephone companies has, at certain points, been directly or indirectly injured by the presence and operation of electric light wires, and an appeal to the courts has been rendered necessary.

Until within a comparatively recent period the disturbance resulting from dynamo current induction was, with an occasional and rare exception, limited to certain evening hours, and to the night, because during such portions only of the day was the lighting circuits in operation. But of late, in many places, the wires used in the night for lighting are also used during the hours of daylight for transmitting power from the dynamo to large numbers of motors which may be widely distributed; and as this utilisation is certain to have in the near future an enormous expansion, we are compelled to face the prospect that even during the hours of business telephone wires are now liable to severe disturbances. Therefore, it seems time to call a halt: we could be patient so long as we were only called upon to suffer from the "pestilence that walketh in darkness," but when we are also threatened with the "destruction that wasteth at noonday," it behoves us to have something to say about it. Super-added to the above causes, we now find that electric railways are being introduced in rapid succession, and we find to our cost that many of them are much more active than are electric lighting circuits in setting up disturbing currents in telephone lines; the disturbing current from electric railways being frequently sufficiently strong to vitalise the annunciator magnets of a telephone central station, and to actuate the drops.

Now, I have no quarrel with electric light and electric railway companies, considered as such. No man rejoices more heartily than I in the triumphs of electricity and in the tremendous spread of its usefulness. I recognise fully, moreover, that the lighting, power and transit utilisations of this mighty form of energy are fully as useful as is its function in carrying intelligence; and that these utilisations have properly become permanent institutions, and, equally with our own, public conveniences. Nevertheless, we were first in the field, and although we may admire both the energy of the electric lighting current and the energy of its introducers, we must, in our own defence, be prepared to take the position that no newcomer has a right to construct his plant in such a way that an established business shall thereby be ruined or impaired; and that if it be absolutely necessary to erect electric light lines in close proximity to telephone lines, the construction must be of such a character as not to involve detriment to the pre-existing telephone lines.

Can electric light and power lines be constructed so as to be near telephone lines without interfering with them? Certainly they can. Consider how the disturbing currents originate: First, most arc lighting circuits can set up considerable induction on telephone lines. Second, alternating currents in main wires, whether used for arc or incandescent lighting, are intensely provocative of induction and noise in telephone circuits, the character of the disturbance being much worse than that which is produced by lightning currents of constant direction, this latter sounding in the telephones like a protracted musical note of great volume. In speaking of the above it will be understood that the detrimental action upon telephones is the same when the dynamo current is used for motors as it is when used for lighting. Third, certain classes of electric railways very seriously interfere with the operation of telephone lines, both in conversation, and also by establishing thereon a current which permanently excites the annunciator magnets. The noises which are produced in telephones by dynamo current induction are so well known that it would be waste of time to describe them.

When the troublesome currents are produced by electric light or motor circuits, they may usually be attributed to induction, although a certain amount of absolute leakage, doubtless, also exists. Since, however, both causes produce in telephone circuits a like effect, it will be sufficient to speak of induction only. But if we consider the action of electric railways upon telephone lines, we find that the major part of the disturbance is due to the actual transference of a portion of the electricity which actuates the train motor to the telephone lines, by way of the rails (when these are used as return conductors), the crust of the earth itself, and the telephone line terminal ground wires.

As most of us know, the alternating current has received lately an increasing amount of the patronage of our light-producing friends; and at the present time both constant direction and alternating currents are largely used in electric lighting and power distribution circuits, the intensity of the disturbance varying with the class of current employed.

The violence of the induction, and, therefore, of the disturbance, depends upon the proximity and longitudinal distance of parallelism of the disturbing wire, the strength of the inducing current, the frequency or rate of change per time unit of the inducing currents, and the extent or range of such change. That which is due to wires carrying alternating currents is, of course, much stronger than even the worst case of direct current induction, for even though the distance of exposure and the strength of the inducing currents be identical, it is self-evident that a current which is completely reversed a great number of times per second, must be much more energetic as a disturber of the peace than one which is constant in direction, and which varies only in strength on one side of the zero line. These considerations indicate that our methods of prevention or cure should be directed at the stronger disturbing agency, since such a degree of success as we may be able to achieve against that will necessarily be equally effective as regards the weaker.

The proper way to cure or neutralise electric light or power induction *is to prevent it*. It is quite within the bounds of good construction so to relatively arrange lighting and telephone circuits that no disturbance will result; and it is obviously much easier and less costly to construct them properly in the first place than it is to change them. To secure this most desirable result—viz., the harmonious co-existence of these widely differing classes of electric service—I wish to point out that co-operation between the parties concerned is absolutely essential, together with a clear and full understanding of the conditions involved. Yet in too many instances, though, as I have stated, where the telephone wires were already in the occupancy of the field, telephone companies have negligently omitted to watch their own interests with sufficient

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care, and have, without remonstrance, permitted electric light companies to erect wires close to their own, and of such a character as to render inductive disturbance a foregone conclusion. Would not a general good understanding between the different electrical interests of any city or town be desirable for the forestalling of such chances of future disagreement? Informal discussion, amicable conference and mutual consideration between the authorities of the several interests would tend to preclude any possible future misunderstanding, and would certainly act to prevent unnecessary antagonisms either between any of the several individual interests or with municipal authorities. A good understanding all round is therefore suggested, as being an admirable forerunner to a system of non-conflicting construction.

Local managers of telephone companies should be instructed to report to headquarters, at once, the intended construction of either electric light or railway circuits at any point within their territory, so that proper measures can be concerted and adopted to meet the special conditions of the case. If the general satisfactory understanding which I have outlined can be reached, it should not, I conceive, be difficult to bring intending electric light and railway officials to see that construction which is innocuous to their neighbours, and which, in virtue of the provisions necessary to secure such innocuousness is thereby made safe in all respects is (all things considered) both cheaper and better than construction which is at any time liable to involve them in trouble, misunderstanding and damages.

The element of distance is of the highest importance. Telephone and electric light wires cannot be too far separated for the efficient working of the former; and the wires last strung should be run, if possible, on the other streets from those in which wires are already in operation. In no case ought the two classes of circuits be nearer together than the width of an average street. In writing the above, I have not forgotten that it is oftentimes a matter of mutual convenience, that reciprocal privileges should be allowed. This idea is by no means in conflict with the general principle that distance is the most efficient neutraliser.

The good feeling and understanding which I have advocated will be productive of a tendency to keep down unnecessary pole construction; and if either interest have a pole line through a certain territory, and if the other party have but a few wires going in that direction, it is doubtless often the best policy and practice to make the existing pole line available for both. By suitable agreement on this head, both telephone and electric light systems are enabled to use each other's poles on occasion, and thus to carry a sporadic line and accommodate a customer in districts which could not otherwise be reached—at least, with due regard to economy. It is, of course, understood than an electric light company thus stringing wires on the poles of a telephone company must properly run its wires so as to produce at most a minimum disturbance, and that a telephone company taking its chance on electric light poles must not expect first-class results, unless it be returned through the region of disturbance. The responsibility in the latter case is on the owner of the telephone wire alone.

If both sides of the street be fully occupied, and it should be really necessary to carry a main route of wires of both systems on the same side of any street, no other street being available (a state of affairs which ought not often to exist), it would, I should say, be better for them to be upon a single line of large poles than for each company to provide its own poles, and thus to incur the enmity of abutters, property holders, municipal authorities and iconoclasts generally, for a uniform style of construction can then be adopted; and as the telephone current is the weaker, the telephone poles should carry both sets of wires, and the construction should be supervised by its officials. This procedure is, however, only admissible if no other route can be found for the wires of that concern arriving last on the ground; and I repeat that wherever circumstances will permit, the width of an ordinary street at least should intervene between the wires of the two systems.

Electric light and power circuits ought always to be metallic, and, in fact, every self-respecting electric light circuit *is* metallic; this, however, being altogether without regard to its relations with contiguous circuits of other classes. But a lighting or power circuit which is contiguous to telephone circuits must not only respect itself, but must respect the telephone circuits also, and hence must not only be a metallic circuit, but must have its two wires parallel and as close togther as possible, so as to be practically equidistant from the telephone wires; this, in order that the inductive effect exercised by the outgoing and incoming wires, may be equal and opposite.

Where the distance of the width of the street is observed the parallel return wire frequently provides all the necessary neutralisation and prevents disturbances, for the neutralisation is necessarily more perfectly effected as the distance of the two wires of the electric light circuit from the telephone wires is increased, because the distance of the two wires of the lighting circuit from one another is a much less factor in a greater distance, such as the width of a street, and the two wires therefore operate much less independently than is the case when each wire is almost as near to a group of telephone wires as it is to its own mate. It is, however, often found (and especially when the two sets of wires are on different horizontal planes of the same poles) that even though the two wires of the lighting circuit be substantially equidistant from the telephone wires, perfect neutrality and noiselessness is not secured; and the degree of remaining disturbance is greater or less according to the distance between the wires of the two systems and the distance that the said two sets run in parallel contiguity. This remaining disturbance manifests itself because the electric light circuit is not balanced. If, for example, one of the two sides of a lighting circuit be made to serve one or more lateral loops, while the other runs straight, or if one be connected with a greater number of lamps than the other, there is no balance; the electrical centre of the main line does not coincide with the mechanical centre, and one of the two wires exercises a much greater inductive influence than the other, the result being noise. By arranging the electric light circuit so that each side shall have an equal number of loops of like length, and an equal number of lamps or motors, and then by transposing or crossing the two wires of the lighting circuit about every fourth or fifth pole, the disturbance may be totally suppressed.

Such care in construction will most naturally be objected to by electric light and similar companies on the plea of expense, especially by such as have already constructed their lines in a style regardless of the rights of others; yet only by an insistance upon such conditions, when the two systems of lines are in close proximity, can the business of telephone companies be protected.

It may also be objected that since the parallel return wire cross connected at intervals with the outgoing wire is a remedy for inductive disturbances, it is one which should be applied by the telephone companies, and to the telephone circuits, as being the complaining party. But as to this, in addition to the already stated fact, that in nearly every case where the pernicious effects of induction are experienced, the telephone company was already in business and its wires in place, and that the disturbance originated with the advent of the electric light wires, and that common justice requires that the aggressor should apply the remedy, it may with reason be rejoined that the number of the electric light wires is much less than that of the disturbed telephone wires, and therefore the remedy may be applied to the former with much greater ease and at much less expense.

We have considered the preventive or remedial measures which are applicable to this evil; and it seems clear that the right time for suggesting the propriety of observing these conditions of neutral construction is before the work has been done, and it is probable that the owners of disturbing wires will be much more willing to heed them, in originally arranging their wires, than where subsequent alteration is required, especially as in original construction the plans suggested would not necessitate the numerous joints inseparable from later transpositions.

In any case, whether such remonstrance or suggestions as may be offered tending to harmless construction be properly received and acted upon or not, it is our duty to offer them, and so to place ourselves in the right, and in this

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unmistakable position of having, at least, done our part in objecting to improper, and in stating our convictions of what constitutes proper, construction.

I have already alluded to electric railways, and to the fact that the weight of the evidence in regard to disturbances developed by them upon telephone lines tends to show that these are due not to induction, but to actual leakage of electricity from the railway conductors to the telephone lines.

There are several classes of electric railway. First, those which utilise the rails for both outgoing and return conductors. Second, those which employ a single overhead conductor, using the rails as a ground terminal or return. Third, those in which the two main conductors are both in a conduit, to which access is had through a slit in the same way as a mechanical cable road is operated, trailing brushes or springs being led through the slit. Fourth, railways which carry their own electrical energy in the form of secondary battery cells. Fifth, railways which employ two overhead conductors—one as the outgoing, and the other as the incoming line.

Of these plans, the first and second are very detrimental to the satisfactory operation of telephone lines; the fourth is perfectly harmless in all respects; and the third and fifth usually are also, and may be readily so made when they are not. All that is necessary to that end is to exercise such care in construction as to insure that the main conductors are properly insulated, and in the case of the fifth plan, that the main conductors are also prevented from coming into contact with overhanging branches of trees.

A great number of electric railways are built upon the second plan, and where they are run near telephone wires invariably exert a pernicious influence thereon, which is largely due to the imperfect return or earth terminals furnished by the rails; a portion of the current passing from them through the earth to the telephone circuits by way of the sub-station ground wires, thus occasioning interference with conversation, and affecting call signal apparatus, and often damaging property.

This class of construction is manifestly improper, both on the score of interference with the telephone wires and as being dangerous, and is of the cheap and reckless order.

When the remedies for its evils are so simple, and consist merely in adding a second overhead conductor and in looking well after insulation, it would seem that they should be properly and universally applied by reason of the greater security they afford, even though those owning railways may have no just regards for the rights of others.

Telephone companies should, therefore, exert themselves and their influence in favour of the double overhead wire and other safe forms of railway, the former being, in fact, safer in other respects and more economical in operation than railways, which in any way utilise the rails as conductors.

When other systems are already in use, and should it be found impossible or impracticable to persuade the railway company to provide a return wire, and where the telephone service is consequently impaired, the only absolute remedy is that of providing the telephone circuits which are affected with a parallel return wire.

The disturbances may, however, be greatly softened down or subdued by carrying the ground end of the subscriber's wire from his office or house to some point at a considerable distance at one side or the other of the railway, and by their terminating it instead of at the sub-station itself. Considerable success has also been attained in practice in the amelioration of this trouble by connecting the leading out-wires of a number of neighbouring disturbed telephone lines with a large common return wire, grounded at or near the central station, instead of grounding each in the ordinary way.

If the leak is so great as to affect the annunciators, it is sometimes requisite that the common return wire, instead of being grounded, shall be connected with the several central office terminals of its group of lines, exactly in the same way that its outer end is united to the outer ends of the individual lines—that is, of course, when these are at rest. By adopting this plan the earth connection is, when the lines are not in operation, completely cut off. If the disturbance does not affect the talking, ground connections can be provided for use during talking. If it does, then the return must be retained during talking also.

Though this paper is already long, there are still one or two points on which I should touch. In one of the children's hymns composed by the late lamented Dr. Watts, occur these lines:

> "One sickly sheep affects the flock
> And poisons all the rest."

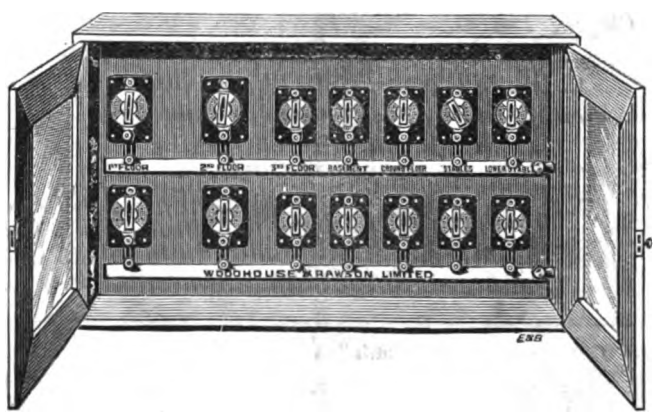
And upon the principle thus enunciated, it not infrequently happens that, though but few telephone wires, or even a single wire, be exposed to disturbance originating in and by the causes recited, the trouble is propagated to others by induction, by reason of the close massing of a large number of wires at or in the vicinity of central stations.

Consequently, one wire adversely affected by electric light or railway disturbance may influence deleteriously many others. The lessons we have to learn from this are, that if we have one wire so affected, we ought, in some way, to promptly attack the evil in that wire, remedying the trouble while it is small and controllable; and that it is essentially our duty to remove dead or unused wires at once, unless there is good reason to anticipate an early resumption of use; and even then they should be disconnected from the two terminal stations; and when I say disconnected, I don't mean simply short-circuited, or cut out, but absolutely detached, dead wire being one of the most prolific and active agencies of disturbance and danger. True, it costs something to take down wire, and it may be troublesome to put them up again when required, but it is the only safe proceeding, and in such matters the anchor ought to be cast windward every time. It is better to spend a few cents in defence than it is to spend possible millions on account of the misdoings of a dead wire in tribute.

Finally, if the number of disturbed wires be smaller than that of those causing the disturbance, or if it be necessary to run a telephone wire through a region of disturbance, the simplest, easiest, and most economical way is not to monkey with the buzz saw, but at once to make the telephone circuit metallic, at least through the region of disturbance, which operation should, moreover, invariably be performed in cases where less drastic measures fail.

SWITCH-BOARDS.

We illustrate herewith one of the switch-boards recently fitted up by Messrs. Woodhouse and Rawson at Messrs. W. H. Smith and Son's Water-street premises. As our



readers are doubtless aware, this firm had the contract for lighting up the whole of the extensive buildings in the Strand and at the back in Water-street, &c. The current is supplied from the Grosvenor Gallery circuit, and the two mains are on the face of the board, with fuses to the main switches controlling each circuit on the line. The thimble connections are sweated on to the end of the cable and brought through to the top of each switch, the board being fixed so that by taking the cover off any main can be taken out without disturbing the board itself, which is of slate on wood battens. The whole is enclosed in a mahogany case with glass doors, which gives it a very neat appearance, and enables the position of the swi ches to be easily seen.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. I., new series, of "THE ELECTRICAL ENGINEER" (Vol. IX., old series) is now ready, and can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

Letters await "Terminals" and "E. E."

NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

LONDON CHAMBER OF COMMERCE.

On Monday, the 22nd inst., at three o'clock, there is to be a meeting of the Electrical Section of the London Chamber of Commerce. The main business of the meeting will be to elect a working committee, consisting of thirty-three members. The section itself has been divided into sub-sections, and each sub-section is allotted a certain number of representatives upon the committee. Thus the cable companies get five members, the telephone companies three, consulting electrical engineers also get four, while thirteen members are given to the electrical manufacturers and contractors, six members to the supply companies, and general electrical engineers get two—making, as we have said, in all a committee of thirty-three.

Undoubtedly the first thing to do was to form this electrical section in the Chamber of Commerce, but by far the most important work is to select the right members upon this committee. We are afraid that the method of voting may, unless great care is exercised, lead to wrong voting. What, for example, does the cable companies sub-section care about consulting electrical engineers? Each section should have selected its own representatives upon the committee, and have had no voice in the selection from other sub-sections. As it is, the men who have worked the hardest and done the most towards the success of the scheme, who have at their fingers' ends the whole ins and outs of the requirements of the general as distinguished from the special parts of the profession, *may*—we do not say *will*—be left out in the cold. It may be said that such fears are groundless, and that the most prominent men in each section are known generally to the members in every section. That statement may be doubted; but if it is true the reply is that there are men prominent not by reason of their ability but from other causes, while there are men less prominent but far more able to guide the destinies of the profession. The latter men are better known in the sphere in which they move, and will hardly be known to some of the members of other sub-sections. Then, again, there are men who should almost claim a seat upon the committee because of their representative character. Who, for example, know the business requirements of large companies better than the managers of the companies? From the commercial point of view they experience difficulties daily in obtaining and transacting business, and we believe one of the main objects of the section is to discuss and, where possible, obtain remedies against restrictions which are in any way found to hamper trade. If, however, the members tackle their task of selection in the broad spirit of determination to put the best men in the forefront of the fight, all will be well; the danger arises from not appreciating the gravity of this question and voting without due consideration and

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due knowledge. It is most important that no question of trade rivalry be involved, and votes should not be given to this man or to that man because this company or that firm ought to have a representative. The committee represents not companies or firms, but sectional interests. The five best men, then, should be selected to represent the cable interest without considering which companies were represented, and so with the telephone interest, and the other interests involved. Once more then, for we cannot put it too plainly, the representatives wanted here are not the men who have made reputations in scientific circles, but rather men accustomed to business life and to business methods. It is the monetary interests of the profession, not the scientific, that are to be dealt with here. The latter can take care of itself and excel in mutual admiration in a hundred different ways—in scientific societies, in books, in newspapers—but, after all, the scientific men are dependent upon the monetary interest for success. The buyers and sellers are the men with whom we now have to deal—their prosperity is to be assisted or retarded, so far as the action of the Chamber of Commerce can assist or retard, according to the selection made on Monday in the constitution of this committee. We have no intention of depreciating the value of science, only to insist that science has no claims in this particular case. If, however, the scientific man be at the same time a man of business, that is another matter, and his claims can be considered from the latter point of view.

The idea has been mooted that the section will consider questions as to individual methods of carrying on business. Nothing can well be further from its object. Only such questions can be considered as appeal to the general welfare. The individual can pursue what method he chooses for carrying on his business, providing he does not run counter to the customs and traditions governing the trade. It may be that there will, in the discussions of the section, gradually grow into existence a consolidated code of accepted customs which, so to speak, will become authoritative. A case to the point may be instanced. A firm, after months of negotiation, after a large expenditure of time, energy, and money, obtains a provisional contract, say, with a corporation. A second firm hears this, and gets to know something of the terms suggested, and immediately commences to influence individual members of the corporation by suggestions for different terms, probably showing a lower expenditure and a greater efficiency, this action resulting in a loss of the work, for usually that comes to grief between the two stools. First-class firms do not condescend to such actions, but, nevertheless, it is far too common an occurrence with firms of lower calibre. But we are wandering from our text, which is not what work the committee may do after selection, but to get the best business men selected. The voting papers have to be handed in within five minutes of three o'clock on Monday.

CORRESPONDENCE.

ELECTRIC LIGHT v. GAS AT BARNET.

To the Editor of The Electrical Engineer.

Sir,—Since we have obtained the contract, and have carried out the lighting at Barnet (the first town in the United Kingdom whose streets are entirely lighted by the electric light), we have been subjected to all manner of abuse from interested opponents in the local papers and elsewhere, chiefly in the shape of anonymous letters (the most contemptible form of criticism), the merest perusal of which is sufficient to show their origin.

The report of a visit to see the electric light at Barnet was published in a Blyth paper as coming from a Blyth man. This report, it is believed, was written by an unfriendly gas shareholder—a resident in Barnet. Of course, it was copied in the *Barnet Press*, and extracts, we regret to say, in some of the electrical papers. The malicious and yet ludicrous nature of that report will be apparent when it is known that the writer states that electric light lamps (of 50 c.p.) gave much less light than an ordinary gas lamp (of about 14 c.p.). The absurdity of this statement is evident by a glance at the two lamps. The writer of the report makes other misleading and erroneous statements.

The editor of the *Luton Times* was, we are informed, invited to Barnet to write down the electric light, and after spending "a very happy evening" (*vide* report), proceeds to do so in a very amusing, but, of course, totally erroneous and misleading manner. It is sufficient to say that he stretches his imagination to the extreme point when he writes that he had to obtain the assistance of a policeman and to borrow the policeman's lantern to enable him to find an electric lamp (of 50 c.p.). We suggest that the policeman had to see him home, and that he occasionally saw stars.

Many other equally stupid and misleading letters and criticisms have appeared, and perhaps a few facts as a corrective may not be out of place.

Now as to the light. This is the first installation of town lighting by incandescent lamps in series, and we had enormous difficulties in obtaining the novel fittings in the short time at our disposal. Our contract was not signed until July 6th, we did not obtain the official plan showing the position and number of the lamps until some time after, and we found that we had to fit up seventy-one street lamps, posts, five miles overhead wire, nearly one mile of underground wire, dynamo, engines, &c., in about five weeks. We asked the local board for six months in which to do the work permanently. This they were unable to grant, as the gas company's contract expired at the end of August, and we had to light up on the 1st September. Under such circumstances we were compelled to use temporary appliances, which we are now replacing by permanent plant, and we expect shortly to have our duplicate sets of engines, dynamos, &c., in proper working order.

Our contract is for seventy-one 32 c.p. lamps. We have substituted many 50 c.p. lamps in the High-street, &c., in order to make a good display, and the opinion of competent and unbiassed persons is that the light is a success, and we are much gratified at the orders we have received for private lighting, and the general good feeling shown towards us by the townspeople of Barnet.

The Barnet lighting is, no doubt, the stepping-stone to an immense business in town lighting. We have already had numerous applications from other towns, and we consider the unfair criticism we have received is due to the envy of our opponents, and we take it as a tribute and measure of the success we have already achieved.

When we are fixed up permanently, of which we will give you due notice, we shall be glad to see you, and explain the whole system, and invite your personal criticism.—Yours, &c.,

Henry F. Joel and Co.

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REPORTING PROGRESS.

The inquirer after electrical trifles, as well as the inquirer after the progress of business in London, will be at the present time plentifully rewarded in his efforts. Everybody, if not gleefully remarking that business is good, will tell you that the immediate prospects are good. There never was a time when electrical engineering work promised more favourably, and it depends solely upon the manner in which the work in hand is carried out whether progress is to be steady and continuous. The man about town is perhaps a creature not altogether to be complimented; but he sees a lot of things and knows a lot of people, and is often very efficient in promulgating news about fashionable things. Last year, in fashionable circles temporary electric lighting played an important part, and, we have no doubt, paved the way, to a greater or lesser extent, to the extensive desire shown since to install the light permanently. Whatever may be the opinion about the system carried out by the Grosvenor Gallery, there is no doubt the profession owes much to the mere fact that through evil report and good report the Grosvenor Gallery installation has been carried on. While companies and firms fluttered and spluttered for a time, and then their place knew them no more, the Grosvenor Gallery work, like the brook, goes on for ever—at least goes on and prospers. It was seen that electric lighting was not that miserable failure that some people would have it supposed, and this year has seen the revivification of the dry bones. Messrs. Latimer Clark, Muirhead and Co. are very busy with the St. James' installation, and in the course of a few days the engines and boilers will be fixed. But another installation of greater magnitude has just come into operation, and we may venture a few preliminary remarks upon it. Along the embankment is one of the finest positions of London. Continuing, in fact, from the National Liberal Club—which is lighted electrically—is a huge block of buildings, now fast approaching completion. On the Whitehall side, below the level of the street, is built a substantial central station. The station is in the form of a parallelogram, and divided into four compartments. One compartment is devoted to the boilers, of which there are three, by Hick, Hargreaves, and Co., of Bolton. These are return tube boilers, and are 9ft. diameter by 8ft. long, with two furnace tubes, each 2ft. 8in. diameter, eighty-six return tubes, and twenty-four stay tubes in each boiler, all 3in. in diameter. The working pressure of the boilers is 160lb., and they have been tested up to 260lb. per square inch. They are constructed of mild steel throughout, except the combustion chamber, tube plates, and tubes. The heating surface of each boiler is about 700 square feet, with a grate surface of 24 square feet. These boilers generate the steam for three Willans' triple expansion tandem engines of 170 h.p. each. The engines are geared direct to three of Crompton and Co.'s dynamos, which are machines with single-limb magnets. The magnets are forgings of soft iron, and in their finished state without the shunt coils weighed about 3·5 tons for each dynamo. The armatures are drum wound with the patent chord-winding, designed by Mr. Swinburne. The weight of copper on the armatures is about 690lb., and on the shunt about 1,200lb. They are shunt-wound to work on accumulators. The output for each machine is 700 amperes at 145 volts, with a speed of 380 revolutions—that is, they are 100 unit machines. The armatures are kept cool by means of a Schiele fan, driven by a small Crompton motor of about 2 h.p. The fan is fixed in what may be termed the heating chamber—the same room that contains the heating apparatus for warming the building. The experience of this firm points out that it is better to have the machines smaller and use a fan than larger without a fan. The question is purely one of initial cost and cost of maintenance. The accumulator to be used consists of Crompton-Howell cells; and it may be remembered that a good deal was said about these cells in the discussion at the Society's meetings not so very long since, so that the performance will be looked forward to with some degree of interest. Various delays have occurred in the completion of this station, and for the time being the lighting of the Avenue Theatre is carried out by direct working, and not from the battery. There are a good many interesting features in the details of this installation, which will be described and illustrated in due time. This installation has been taken over by the new company recently floated, but Mr. J. E. H. Gordon is responsible for the whole of the arrangements, from the first inception of the scheme to the present time.

ON THE EFFECTIVE LENGTHS OF STEEL MAGNETS.*

These experiments were made with three different specimens of steel of very approximately known composition, and form a supplement to two sets of results got from the same samples of steel, which were published in the March and May numbers of the *Phil. Mag.* last year.

From each sample of steel there were cut lengths varying from 1 to 20 cms. These were carefully straightened and the ends made accurately at right angles to their lengths. They were then made glass-hard by being brought to a bright red heat, and suddenly cooled in a deep vessel of water at a temperature of 7 deg. C.

After being cleaned, measured, and weighed, they were severally put through a series of observations for the purpose of calculating their magnetic moments per gramme, which was done from the following formula:

$$M = \frac{H \tan \theta \, (r^2 - l^2)^2}{2 r W}$$

where

r = distance in cms. of the centre of the magnet from the centre of the magnetometer needle.

l = half the distance in cms. between the poles of the deflecting magnet.

H = the horizontal component of the earth's magnetic force.

θ = the deflection in degrees of the magnetometer needle.

W = the weight of the magnet in grammes.

The following table gives the data and calculated magnetic moments of the various magnets made from the three different specimens of steel:

Length and dia. of Magnet in cms.	Dimension ratio l/d.	Weight of Magnet in Grms.	Magnetic Moment per Gramme.
Specimen I.			
20 × ·3	66·6	11·0	59·9
15 ,,	50·0	8·25	59·0
10 ,,	33·3	5·5	57·0
8 ,,	26·6	4·4	51·9
6 ,,	20·0	3·3	44·8
4 ,,	13·3	2·2	32·5
2 ,,	6·6	1·1	15·2
1 ,,	3·3	·55	6·96
Specimen II.			
20 × ·265	75·5	8·6	90·5
15 ,,	56·7	6·4	83·7
10 ,,	37·7	4·3	71·0
8 ,,	30·2	3·44	64·6
6 ,,	22·6	2·58	53·8
4 ,,	15·1	1·72	41·2
2 ,,	7·6	·86	12·4
1 ,,	3·8	·43	5·5
Specimen III.			
20 × ·27	74·1	9·0	78·4
15 ,,	55·6	6·75	75·0
10 ,,	37·0	4·5	70·0
8 ,,	29·6	3·6	59·6
6 ,,	22·2	2·7	45 4
4 ,,	14·8	1·8	27·3
2 ,,	7·4	·9	10·7
1 ,,	3·7	·45	5·0

* Abstract of a paper read before the Physical Society of Glasgow University, October 12th, 1888, by W. Brown, Thomson Experimental Scholar.

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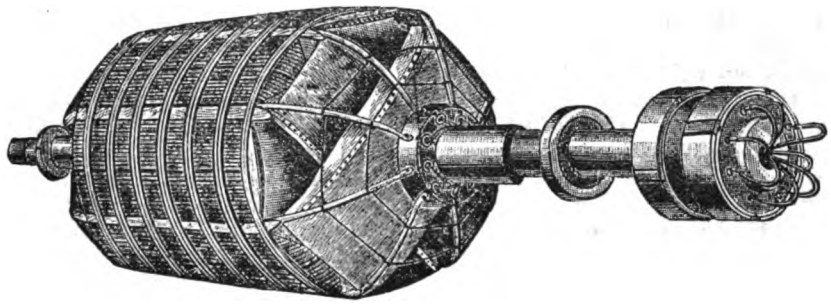
THE SCHUYLER ARMATURE.

The Schuyler Company has adopted the form of armature shown in the accompanying illustration. It is of drum type, with four coils, the core built up of sheet-iron rings. The ends are open, to allow of free circulation of air. The coils are separated from each other by wood strips secured to the drum. Each coil is wound in two parts. Our contemporary, the *Electrical World*, says:

"Each coil is wound in two parts, one-half the full number of layers deep on either side of the shaft, and the two inside ends spliced together, maintaining the proper direction. This leaves both ends on the outside, and obviates the delay and expense of removing an entire coil in case of a broken inside end. With the connections and commutator used on this armature the current is constantly flowing through two coils in multiple and one in series, leaving one between the brushes cut out, thus making less strain upon them than if in circuit continually. Another advantage is that in case of a possible accident to any one coil it can be disconnected with its mate at right angles, and the machine still be able to carry part of its load. The terminals of the coils are secured to an insulated collar, from which the shaft wires are connected to the commutator. Attention has also been given to the continuous lubrication of the bearings, so that the machine may be operated for a long space of time without attention."



The Schuyler Armature.

OVERHEAD AND UNDERGROUND WIRES IN NEW YORK.*

BY DR. SCHUYLER S. WHEELER.

After an historic introduction, the author said:

The difficulty of the problem, and the reason why the experience of other places are of so little value to us, will be seen when it is considered that the number of wires in a given space in New York, taking the average, is very much greater than in any other centre in the world.

The places between which these wires run, instead of being in an approximately circular area, as in the case of the three other leading electrical cities, are drawn out on a long and very narrow island, thus crowding the conductors together, and increasing their length between points. In addition to the difficulty of a much greater amount of wire and less area to contain it, there is the great difference in rapidity of business, which makes it necessary to be able to put up and remove wires and instruments here more speedily than in the older cities.

The ground was so filled with gas, water, and steam pipes, sewer and pneumatic despatch tubes, and their connecting boxes and man-holes, that it was impossble to find a straight course for a conduit or even a small number of ducts; and the repairs to these, which are continually going on, would make the wires specially liable to disturbance and injury. The earth is saturated with gases from the various pipes, and this would collect in any open space, such as the subways would afford, destroying the insulation of the cables, suffocating the workmen, or causing explosions. In comparing wires with gas mains, it is sometimes said that the former are much more difficult to bury successfully than the latter, because the leakage does serious harm, while the leakage from the gas-pipes is of no consequence. It is true that the loss from escaping gas does not cripple the gas companies' business, at their present prices, but the gas fills the earth, gets into the electrical conduits, and there makes a very bad combination, for which electricity has to stand the whole blame. Indeed, if it were not for the gas, the underground wire problem would be easier, and very much more agreeable. On the other hand, when the electric current wanders off and melts the iron of the gas-pipe, electricity again has to stand the blame, and thus there is not a fair distribution of the responsibility.

In order to treat the subject thoroughly, the board of electrical subways, of the City of New York, investigated all the different systems in use in other cities, in connection with the many plans which were submitted for approval to be used in New York.

It was found that in Paris, they are fortunate in having extraordinarily large sewers, through which (in the streets where sewers run) all of the wires are laid, together with the water pipes. These sewers consist of a large arched passage with a flat floor, through the centre of which runs a deep trench or canal for the sewage. The flat pavement on either side of this forms a broad walk, over which the pipes and wires are suspended from the arched roof. A rail is laid on either side of the canal, and on the track so formed a car can travel carrying a drag which is used in cleaning the canal or sewer proper. In the streets which do not have these sewers the wires are strung upon the housetops.

The only other place which at that time furnished experience at all applicable to the problem here was London. But here there were and are now, practically, no arc lights at all, and therefore no circuits; there are extremely few incandescents, with no out-door circuits; the telephone is not used very extensively, and the wires of the telegraph are placed underground by the Government. The plan employed is what might be called the hand-hole "drawing-in" system, and consists of five-inch cast-iron pipes laid under the sidewalks and accessible through hand-holes or "flush-boxes." These pipes are said (I do not know how correctly) to be loosely jointed for the purpose of admitting water to preserve the cables, which are of gutta-percha, the same as is used for submarine cables, and which deteriorate very rapidly when exposed to the air. In other words, they have learned by their experience with ocean cables how to make insulation which will stand the water, so they try to convert the subway problem into the same kind of work. Conduits have been laid at a later date in other places.

In Brooklyn there are about ten miles of Dorsett conduit, and about four and a-half miles of conduit consisting of a wooden box made of creosoted boards loosely put together, with narrower ones slid into grooves on the inside to form partitions. This duct, being loose and unstable, simply affords a means of keeping cables from touching each other and keeping them in place; and as creosote will dissolve rubber, it is not a good place in which to put a rubber cable.

Another plan, which has seen some slight use in Philadelphia, is the Johnstone system. This consists of a broad, flat, cast-iron duct, made in sections, about 6ft. long, and divided horizontally into an upper and a lower half or shell, so that a section can be removed and another substituted without cutting the wires already drawn into place. The duct is divided into a number of smaller ducts, for classifying the wires, by partitions consisting of long slabs

* Abstract of paper to National Electric Light Association.

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of cast iron, which are slid into place in grooves cast in the inside of the outer shell. The feature of this system is the facility which it affords of introducing an outlet from the duct exactly opposite any lamp-post or desired part of a building, by taking off the upper or lower half of a single section and putting in its place a new half section with a hole in it at the desired point, to which a branching elbow can be bolted.

This construction has been authorised for a distributing system in New York, on Broadway, from Fourteenth to Thirty-fourth streets, for arc lighting, &c. The work is now being prepared, and the system is, therefore, of some interest.

There goes with this style of conduit a man-hole formed of a bottom, a top, and variable numbers of rings or sleeves placed upon each other, so as to build up the height of the man-hole, and permit of the ducts being run out at any depth to escape pipe obstructions, &c. One of these sleeves is split up into a number of panels bolted together, any one of which can be taken off to allow the ducts to be run out on either side at any angle.

All of the other plans by which wires have been put underground, except the Dorsett and other man-hole "drawing-in" systems used in this city, which will be described later, consist of nothing but the wire with covering buried in a trench, and are of no value beyond the taking care of their own particular wire.

Prominent among such plans may be mentioned the Edison tubes. This system, which has been extremely successful for its one kind of service, consists of heavy copper rods wound with rope, and laid in wrought-iron pipes filled with an insulating compound composed of Trinidad asphaltum, resin, paraffin, and linseed oil. This compound is run into the pipe when heated to about 300deg. Fahrenheit, under considerable pressure, while an exhaust is applied to the other end for the purpose of drawing out all air bubbles. The ends of the tubes are then plugged with wood soaked in paraffin, leaving the coppers projecting.

The chief peculiarity of this system of conductors, and the feature which is, perhaps, most familiar to all, is the means of connecting up these lengths of tubing and conductors. The rods are connected by short pieces of copper cable terminating in suitable copper sleeves, which are soldered to the ends of the rods when in position, and the bow-shaped expansion joint so formed is covered with hot compound poured into a small cast-iron coupling box, which is bolted on to the junction. The lines terminate at the street crossing in large cast-iron boxes, like man-holes, where the rods are joined by heavy copper cables to a suitable connecting device near the top.

This plan is too expensive, except for very heavy conductors, but serves admirably the requirements of incandescent lighting. In the early days of the system the thin pipes were greatly damaged by picks in digging around them and by outside disturbances. A slight blow from a pick would puncture the pipe, letting in a little water, which was liable in time to form an arc between the conductors, which would in turn burn the compound, converting it into a conductor, and forming a cross. The greatest difficulty with these tubes was found to be that the insulator would be converted into carbon by the charring action of leaks at the slightest start.

Tubes of the same style, but containing a large cable of small wires, have been in successful use in carrying telephone wires out from the Twenty-first-street exchange in New York.

Another method somewhat similar is the Brook's system, which consists of wires covered with cotton and drawn through large iron pipes, which are afterwards filled with a heavy resin oil, so as to prevent the water from entering. This oil is a good insulator.

The remaining plans are of a lower grade of mechanical construction, and consist of wires and cables of various kinds laid in troughs, and covered with some protecting substance, usually tar or asphaltum.

Among these may be mentioned the few telephone and telegraph wires in Boston, made into a cable laid in a trough and covered with bitumen. A few telephone wires in New York and electric light wires in Pittsburgh are laid in the same way.

There are also innumerable places where cables of various kinds are laid directly in the earth, sometimes with a board covering to protect them from men with shovels. But none of these are of special interest to us, because, obviously, we cannot use them.

The result of the investigations of the commission were summed up in their second report, dated June 30, 1886, as follows:

"The principal systems of electrical subways may be divided, first, as to their material composition, and second, as to their mechanical construction, and the manner in which the wires are placed in them.

"As to material composition, subways are: 1. Of insulating material, such as wood, glass, concrete, &c. 2. Of conducting material, such as iron.

"As to mechanical construction, subways are, generally speaking. 1. Tunnel systems. 2. Drawing-in systems. 3. Solid systems. 4. 'Dropping-in' systems. 5. Combined systems.

"Tunnel systems, or those where space is provided underground sufficient to allow the passage to and fro of men who place the wires within the subway, could be recommended, were unlimited time and money at the disposal of the commission; but the expense of such a system and the crying need of immediate action preclude the adoption of such a plan. If ever underground railroads become a feature of our city transportation, then, perhaps, the tunnel can be used for some of the future trunk line cables.

"In Paris, where the foundations of the city are honeycombed in all directions by large sewers, such a plan is practicable and admirable, but not to be thought of in New York.

"Drawing-in systems, or those where man-holes are provided in the streets, connected by tubes or pipes, through which the wires can be drawn, are next in prominence and convenience to tunnel systems.

"In Chicago there were seen in successful operation nearly twenty miles of conduits of the 'drawing-in and out' pattern of various materials, containing all kinds of wires, as follows: Eight miles of the Dorsett system of concrete conduit divided into ducts, and containing in the separate ducts wires of the city telephone, telegraph and fire service, electric light wires, and wires of different telegraph companies. Four miles of the Johnstone system of iron conduit divided by metal shelves, and carrying the wires of the Postal Telegraph Company. One mile of 3in. iron pipes four in number, carrying the wires of the Western Union Telegraph Company. Three miles of iron pipes, carrying the wires of the Bankers' and Merchants' Telegraph Company.

(To be continued.)

CITY AND GUILDS OLD STUDENTS' ASSOCIATION.

The fourth annual dinner of the Old Students' Association of the City and Guilds of London Institute took place at the Holborn Restaurant last Saturday, under the presidency of Mr. W. F. Pettigrew, and was a very successful meeting, being attended by over seventy members and visitors. The speechmaking was very pleasantly interspersed with songs and music, giving a variety to the proceedings, and bronze medals awarded for the best papers of the previous years were presented during the evening. The chairman having proposed the usual loyal toasts, "The City and Guilds of London Institute" was proposed by Mr. H. Newman Lawrence. Prof. W. C. Unwin replied on behalf of the Central Institution. After regretting the absence of Sir Philip Magnus, who would be the proper person to reply, Prof. Unwin alluded to the fact that this was the first time that the Central Institute was officially represented at these meetings, and trusted the union would lead to important benefits to both. He wished the present and past students to look upon their connection with the institute in the same way as past graduates regard the universities. Oxford was regarded by old students as the home of ineffable delights and the source of almost impossible

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loyalties, and although it could hardly be the same at the present moment, yet he hoped in time the institutes would become an influence such as Oxford to its old members. Prof. Silvanus Thompson, also replying to the same toast, but on behalf of the Finsbury Institute, regretted the fact that the extension of its field of usefulness had not gone on so quickly as he had wished, and at one time anticipated. Their wings had been clipped, and they were still waiting for the extension of the buildings rendered necessary by increasing demands of the students' requirements. One of the City companies, he was sorry to say the Drapers' Company, after having been one of their largest benefactors, had withdrawn their support from the institute. The work, however, was still carried on vigorously, and they had not stood still, and the reputation of the college had, he might say, increased. One way in which past students could help them in the present work was from their own experience after leaving, by giving advice and help in order to make the teaching still more useful practically. Prof. Thompson alluded to the movements afloat for providing technical institutes, and deprecated the establishment of so-called Polytechnics with a swimming bath and a few technical classes. He alluded to the fact that Zurich had determined to expend £55,000, in addition to what it already possessed, in establishing a physical laboratory. This amount, which Zurich intended to spend upon one single laboratory, would cover the whole expenses of our English technical institute at Finsbury. He trusted the outcome of the recent conferences would convince Englishmen more and more of the necessity in the present competition of really first-rate technical education. Prof. Perry, in proposing the toast of the "O.S.A.," said that the papers read before the Old Students' Association could hardly be improved, and were well worthy of being read before any of the scientific societies. The history of the O.S.A. had, he said, no history of wonderful students who had become renowned scientific men to look back to, but this, he was sure, would be the case in future years, and among those before him were those very students. This association, he forcibly said, was not the only association of old students of the institute in the world; the students' meetings of the Society of the Telegraph-Engineers was largely a "City and Guilds of London Old Students' Association," and when, in time, that society itself became the Electrical Institute, that also would be a branch of the same Old Students' Association; and it would, he believed, be the same with the whole of the various scientific societies. Mr. Rance, the hon. secretary, announced that there were 36 new members, and 13 new associates, many of them from the Central Institute; they started the year with a total of 150 names. Prof. Ayrton proposed "The Honorary Members," which was replied to by Mr. E. C. Robins, F.S.A. Prof. Meldola proposed "The Officers," replied to by Mr. F. M. Smith, who stated the interesting fact that the association had a balance of £9 in hand. The toast of "The Visitors" was proposed by Mr. W. E. Sumpner, coupled with the name of Mr. C. H. W. Biggs, editor of *The Electrical Engineer*. The bronze medals presented during the evening were awarded to Mr. A. W. Slater, for his paper during the past year on "Torpedoes"; to Mr. M. H. Kilgour, for his paper during the second year on "Telephones"; and to Mr. Reginald J. Jones for his paper, read during the present year, upon "Installation Breakdowns." The meeting was eminently a success, and in all respects the success achieved by the association must be regarded with great pleasure.

ON THE APPLICATION OF ELECTRICITY TO THE WORKING OF A 20-TON TRAVELLING CRANE.

BY W. ANDERSON, M.I.C.E.

In this paper, read before the British Association at Bath, the author said one of the travelling cranes in the foundry of the Erith Iron Works was originally constructed to be worked by hand, but preparations had been made for the application of wire-rope driving at some future time.

The crane is of 39ft. 6in. span, and consists of a pair of wrought-iron girders resting on end carriages, each running on two wheels on an elevated line of rails. The gearing for hoisting longitudinal and cross-traverse is secured on to the tops of the main girders, the hoisting chain passes from the barrel, which is at one end of the crane, over a pulley at the other, then back to pulleys in the cross-traversing carriage which runs between the main girders, thence through a falling block, and finally to an anchorage under the barrel at the extreme end of the main girders. By this arrangement the crane occupies a moderate height, and the hook can come within 3ft. of each wall.

The inconveniences and wear attending the use of rope-driving gear, or of a long main-driving shaft, and the dirt and special attention required by a steam-crane, induced the writer to try whether electricity might not be used with advantage. Messrs. Elwell-Parker, of Wolverhampton, were communicated with, and these gentlemen undertook to supply the dynamo and a motor suitable for the peculiar requirements of a heavy crane. The dynamo, which is considerably larger than is needed for the crane in question, is arranged to give up to 80 amperes at 120 volts, with 1,200 revolutions per minute. The armature is of the cylinder type, field-magnets shunt wound, resistance of armature ·07 ohm, and of the magnets 75 ohms. It is fixed in the main boiler-house of the works, and is driven by a horizontal engine having a cylinder 9½in. diameter, 12in. stroke, running at 180 revolutions, with 50lb. steam, by means of a link belt. The leads from the boiler-house up to the conductor in the foundry for a distance of 60 feet are of No. 6 B.W.G. copper wire, while the conductor in the foundry is formed of an angle-iron bar, 2in. by 2in. by ¼in., extending the whole 350ft. length of the shop; it has one face roughly ground, and protected from rust by vaseline, and is secured to the iron pillars supporting the roof, being insulated by wood blocks. The return current travels along one of the rails on which the crane runs, the joints of the rails being united electrically by copper staples. The motor is one of Messrs. Elwell-Parker's latest types with single vertical magnet and a drum armature. It is shunt wound, and constructed for 100 volts and 50 amperes; the armature resistance is ·056 ohm, that of the shunt 49·2 ohms. It is fixed on the working platform of the crane beside one of the main girders; its driving spindle carries a steel pinion, which gears into a double helical spur-wheel, keyed on to a shaft which runs longitudinally on the top of the girder, and is connected by nests of three bevel wheels, with friction clutch connections, to the three shafts which command the several movements of the crane, the means of using the hand-power being still retained. Two sets of speed are arranged for each of the movements—namely:

Hoisting slow, 3·4ft. per min., fast 10ft. per min.
Cross traverse, 25ft. ,, ,, 105ft. ,,
Longitudinal traverse slow, 78ft. ,, 213ft. ,,

To provide against an undue current passing through the motor, an automatic magnetic cut-out is fixed on the crane, and, as an additional security, a fusible wire is placed close to the dynamo to provide for the contingency of a short circuit. For the purpose of varying the power and speed to meet the requirements of the foundry a set of resistance

TABLE A.—EXPERIMENTS ON ELECTRIC FOUNDRY CRANE.—Erith Iron Works, August, 1888.

—	Load on Hook.	Total Load on Rails.	Volts at Dynamo.	Amperes in Circuit.	Watts at Dynamo.	Watts at crne (mean)	Horse-powr at crane (mean).	Speed of MotorRevs. per Minute.	Speed of Crane Movement Ft. per Min.
Cross traverse, quick gear	...	18 tons 0 cwt.	120	27	3,240	3,202	3·78	1,166	105
Long traverse, ,, ,, ...	...	,, ,,	105	48	5,040	4,925	5·81	1,100	201·3
Hoisting, ,, ,, ...	...	,, ,,	110	22	2,420	2,398	2·83	1,166	9·92
Cross traverse, ,, ,, ...	4 tons 12 cwt.	22 tons 12 cwt.	98	47	4,606	4,493	5·3	1,100	99
Long traverse, ,, ,, ...	,, ,,	,, ,,	86	80	6,880	6,560	7·74	1,050	192
Hoisting, ,, ,, ...	,, ,,	,, ,,	90	76	6,840	6,551	7·73	1,050	8·92
Cross traverse, ,, ,, ...	9 tons 11¾cwt.	27 tons 11¾cwt.	130	65	8,450	8,229	9·71	1,166	105
Long traverse, ,, ,, ...	,, ,,	,, ,,	115	78	8,970	8,666	10·23	1,166	213
Hoisting, slow gear	,, ,,	,, ,,	103	58	5,974	5,806	6·85	1,117	3·27
Cross traverse, ,, ,, ...	14 tons 2¾cwt.	32 tons 2¾cwt.	112	44	4,928	4,831	5·7	1,166	25·3
Long traverse, ,, ,, ...	,, ,,	,, ,,	135	38	5,130	5,058	5·97	1.333	89·3
Hoisting, ,, ,, ...	,, ,,	,, ,,	115	73	8,395	8,125	9·59	1,133	3·317
Cross traverse, ,, ,, ...	19 tons 2¾cwt.	37 tons 2¾cwt.	135	51	6,885	6,752	7·97	1,266	27·5
Long traverse, ,, ,, ...	,, ,,	,, ,,	130	46	5,980	5,874	6·93	1,250	83·7
Hoisting, ,, ,, ...	,, ,,	,, ,,	98	86	8,428	8,058	9·95	1,016	2·976

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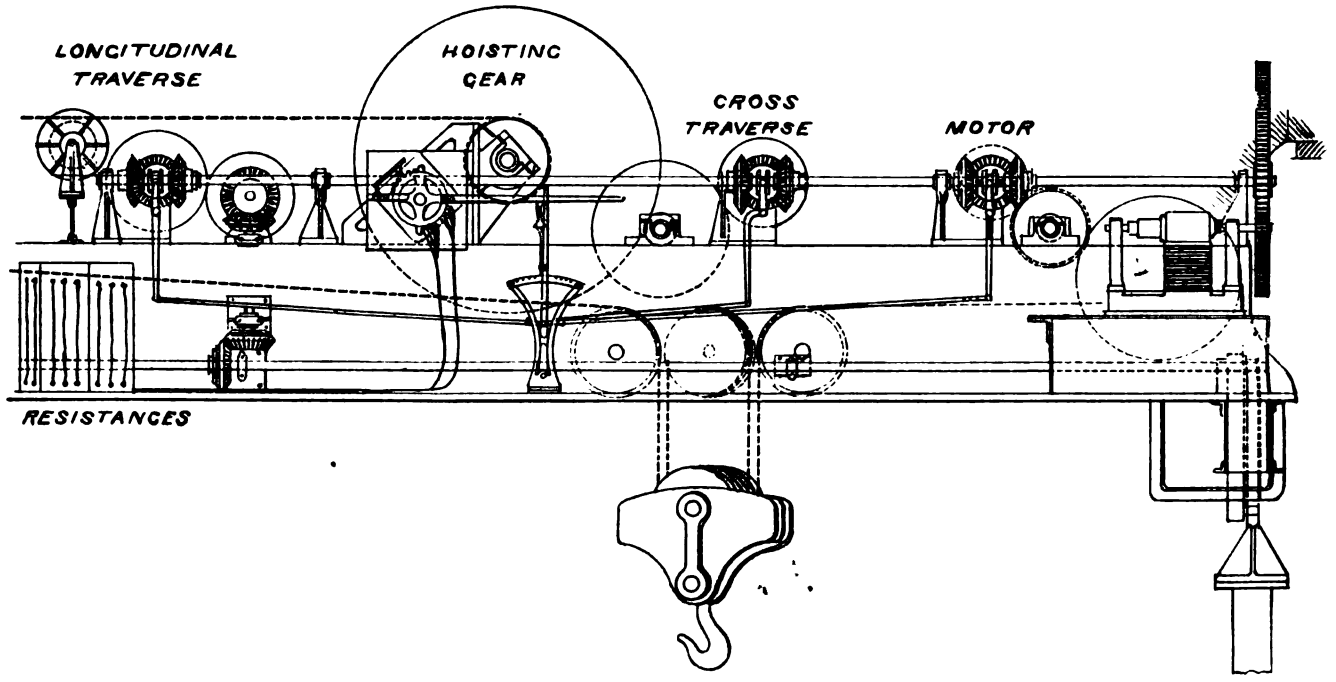
coils is provided, governed by a special switch, by means of which different resistances can be introduced into the armature circuit of the motor, and the current can be cut off altogether, but so that it must be done by steps, and not suddenly. In starting the motor, the reverse action takes place. The shunt coils of the magnets are connected to the two collectors, so that the fields are always excited when the dynamo is running, whether the motor is working or not, the switch controlling only the armature circuit. The collector for the angle iron

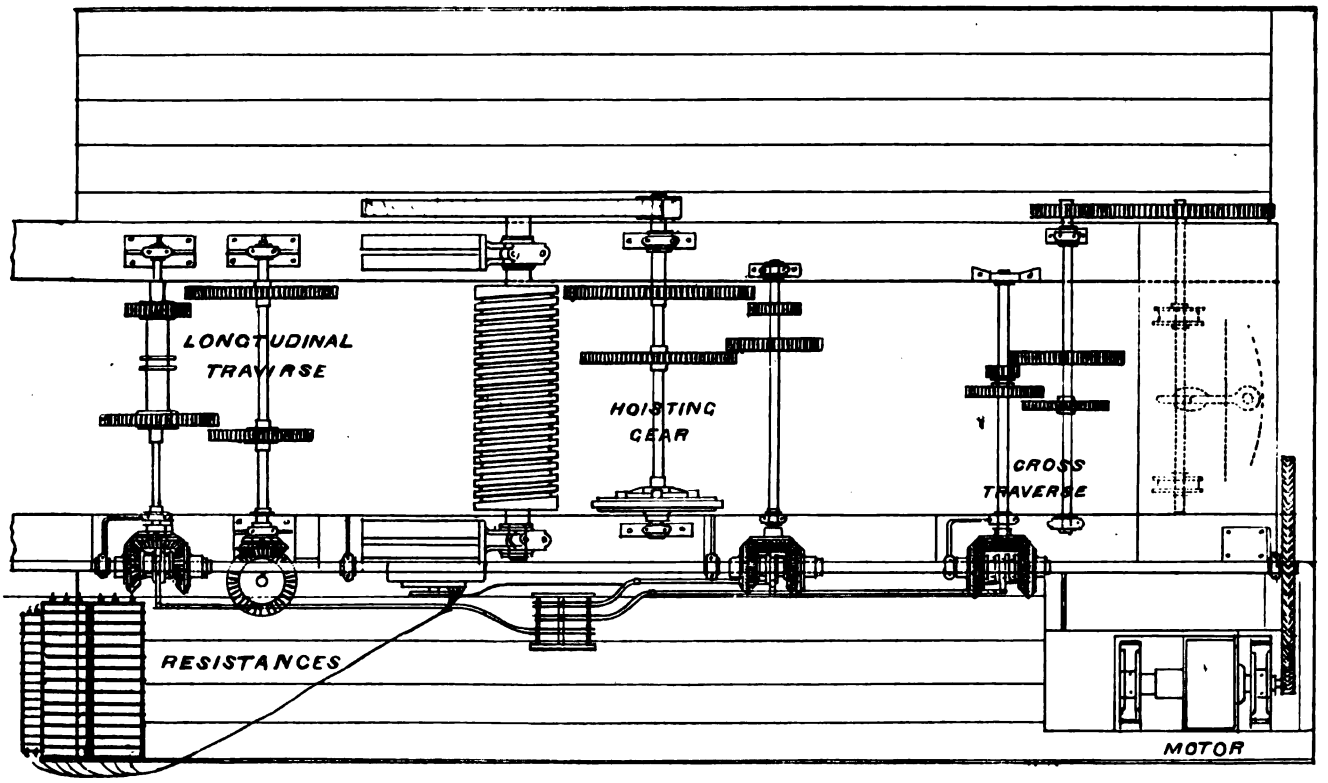
engines of an economical type. The steam from the main boilers is necessarily always available when the factory is at work, and the current can be easily carried into any part of the establishment. Steam-cranes require the attendant to be at his post an hour or more before the works open, water and fuel have to be hoisted on to the crane, and the working is accompanied by dirt, steam, and smoke, the latter especially objectionable with overhead lights or in shops where bright work is prepared or erected.



20-ton Travelling Crane—Elevation.

conductor consists of a pair of insulated brass blocks pressed against it by means of a flat spring, having a considerable range. An ordinary wire brush serves to collect the current from the rail, but the axle of one of the wheels is also connected to this brush to provide for the contact being in any way interrupted.

The duty realised is about 65 per cent. of the power developed in the driving steam-engine. As far as can be judged at present, there is no special wear to apprehend, the conductors act satisfactory, though a considerable length is in the open air, and the dust, heat, and smoke of the foundry do not appear to affect the working.



20-ton Travelling Crane—Plan.

The handles for operating the several movements, the brake lever, the switch and the automatic cut-out are all collected together, so that a single attendant can readily work the crane from one spot.

The crane was set to work in June last, and has continued to act satisfactorily ever since. The advantages of working by electricity are very great, especially in comparison to steam-cranes. In large works a powerful dynamo would be established and be driven by

Table A (see preceding page) gives the electrical measurements made by Mr. E. W. Anderson, to whom the author is indebted for carrying out this comparatively novel application of electricity.

When first proposed, the writer was not aware of the existence of any other electric crane, but he has since learned that Messrs. Mather and Platt, of Manchester, have had one working satisfactorily for some time, and that there is one also in France.

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ELECTRIC TRAMROADS IN AMERICA.

IN OPERATION.

Place and Name.	*System.*	*No of Cars.*	*No of Miles.*
Carbondale, Pa.			
Carbondale and Jermyn Electric Street Ry	Sprague	3	2
Harrisburg, Pa.			
E. Harrisburg Pass. St. Railway	,,	6	4·5
Richmond, Va.			
Richmond Union Pass Railway	,,	40	12
Salem, Mass.			
Naumkeag Street Railway	,,	6	2
St. Joseph, Mo.			
Union Railway Co	,,	8	5
St. Joseph Extension	,,	10	6
Wilkesbarre, Pa.			
Wilkesbarre and Suburban Street Ry.	,,	7	3·5
Wilkesbarre Extension	,,	3	1·5
Wilmington, Del.			
Wilmington City Railway Co	,,	3	7
Ansonia, Conn.	Thomson-Houston		
Derby Horse Railway Co		3	4
Appleton, Wis.			
Appleton Electric Railway Co	,,	4	3·5
Binghampton, N.Y.			
Washington St. Asylum and Park Ry. Co.	,,	6	4
Brooklyn, N.Y.			
Jamaica and Brooklyn Railroad Co.	,,	11	8
Dayton, O.			
White Line Street Railway Co.	,,	12	9
Detroit, Mich.			
Detroit Electric Railway Co.	,,	2	1·25
Fort Gratiot, Mich.			
Gratiot Electric Railway	Reported in Port Huron		
Lima, O.			
Lima Street Railway Motor Co	,,	4	4
Port Huron, Mich.	Thomson-Houston		
Port Huron Electric Railway		8	4·25
Revere, Mass.			
Revere Electric Railway	,,	1	1
Scranton, Pa.			
Scranton Suburban Railway Co	,,	6	5
St. Catherine, Ont.			
St. Catherine's, Merriton and Thorold Street Railway Co	,,	8	6
Third Ward Street Railway Co	,,	8	4
Wheeling, West Va.			
Wheeling Railway Co	,,	12	5·5
Windsor, Ont.			
Windsor Electric Street Railway	,,	21	5
Washington, D. C.			
Eckington & Soldiers' Home Elec. Ry. Co.	,,	3	2
Asbury Park, N. J.			
Sea Shore Electric Railway Co	Daft	20	4
Baltimore, Md.			
Baltimore Union Pass. Railway Co.	,,	4	3
Cincinnati, Ohio	,,	2	·75
Easton, Pa.			
Lafayette Traction Co	,,	2	1
Ithica, New York.			
Ithica Street Railway Co	,,	2	1
Los Angelos, Cal.			
Los Angelos Electric Railway Co.	,,	4	4
Mansfield, Ohio.			
Mansfield Electric Railway Co.	,,	5	4·5
Meriden, Conn.			
Meriden Electric Railway Co	,,	8	5
Pittsburg, Pa.			
Pittsburg, Knoxville & St. Clare St. Ry.	,,	5	3
Suburban Rapid Transit	,,	2	1
Detroit, Mich.			
Highland Park Electric Railway Co.	Fisher	4	3·75
East Detroit & Grosse Point Railway Co.	,,	6	7·50
San Jose, Cal.			
San Jose Motor Co.	,,	12	6
Allegheny, Pa.	Bently-Knight		
Observatory Hill Passenger Railway Co.		4	4
Woonsocket, R. I.			
Woonsocket Street Railway Co.	,,	10	4
Birmingham, Conn.			
	Henry	4	4
San Diego, Cal.			
San Diego Street Railway Co.	,,	5	2
Columbus, Ohio.			
Columbus Electric Railway	Short	4	2
Huntington W., Va.			
Huntington Electric Railroad	,,	4	3
St. Louis, Mo.			
St. Louis Electric Railway	,,	10	2
Totals		310	175·5

PROJECTED.

Place and Name.	*System.*	*No of Cars.*	*No of Miles.*
Akron, O.			
Akron Electric Railway Co	Sprague	12	6·5
Asheville, N. C.			
Asheville Street Railway Co.	,,	4	3
Boston, Mass.			
West End Railway	Sprague	20	12
Brockton, Mass.			
East Side Street Railway Co.	,,	4	4
Cleveland, Ohio.			
East Cleveland Railway Co	,,	16	10
Davenport, Ohio.			
Davenport Electric Railway	,,	8	3
Erie, Pa.			
Erie City Pass. Railway	,,	20	12
Hartford, Conn.			
Hartford & Weathersfield Horse Ry. Co.	,,	6	2·5
Lafayette, Ind.			
Lafayette Street Railway Co.	,,	9	3
Manchester, Va.			
Manchester Street Ry. Improvement Co.	,,	10	3·5
Reading, Pa.			
Reading and Black Bear Railway	,,	2	1·5
Richmond, Va.			
Richmond City Railway	,,	30	16
Sandusky, Ohio.			
Sandusky Street Railway Co.	,,	6	6·75
Scranton, Pa.			
Scranton People's Street Railway Co.	,,	20	12
Stubenville, Ohio.			
Stubenville Street Railway Co.	,,	6	2·5
St. Joseph, Mo.			
Wyatt Park Railway	,,	8	5·5
Bangor, Me.	Thomson-Houston		
Bangor Street Railway Co.		4	5
Danville, Va.			
Danville Street Car Co.	,,	4	2
Des Moines, Iowa.			
Des Moines Broad Gauge Railway Co.	,,	8	7·5
Hudson, N.Y.			
Hudson Street Railway Co	,,	3	2·5
Lynn, Mass.			
Lynn and Boston Street Railway Co.	,,	1	1
North Adams, Mass.			
Hoosac Valley Street Railway Co.	,,	6	5
Omaha, Neb.			
Omaha and Council Bluff Railway and Bridge Co.	,,	12	9
Seattle, Wash. Territory.			
Seattle Electric Railway	,,	5	5
Wichita, Kan.			
Riverside and Suburban Railway Co.	,,	3	2
Newark, Ohio.			
Newark and Granville Electric Railway	Bidwell	5	7
Detroit, Mich.			
Metropolitan Railway Co.	Fisher	15	4·75
Totals		247	153·5

LONDON CHAMBER OF COMMERCE.

The following notice has been sent by the secretary (Mr. K. C. Murray) to the Electrical and Allied Trades' Section:

Sir,—Your attendance is specially requested at a meeting which will be held at Botolph House, Eastcheap, on Monday, Oct. 22, at 3 p.m., for the purpose of completing the organisation of an Electrical Trade Section of the London Chamber of Commerce, on the lines of my circular letter of the 24th of July last. The appended agenda of business will be transacted, and your attention is specially called to the list of members of the section which, for purposes of ascertaining the representation to which they will be entitled on the general committee, has been divided into sub-sections. The working committee, as a whole, will consist of thirty-three members, and you are requested to fill up the enclosed voting paper, according to the directions given thereon, and return the same to me as early as possible before the meeting takes place, whether you are able to attend or not To facilitate the scrutiny it has been agreed that no voting papers will be received later than five minutes after the opening of the proceedings.

Agenda.

1. To receive and adopt a report from the organising committee with reference to the future working of the section.
2. To consider the subjects to be dealt with by the section.
3. Election of the working committee of the section (result of the voting to be announced).
4. Other matters.

ELECTRICAL TRADES' SECTION.

Report of the Organising Committee, adopted Oct. 12, 1888.

The committee appointed at the general meeting held on the 27th of July last, "with a view to organising an Electrical Trades' Section under the auspices of the London Chamber of Commerce," beg to report that in the interval which has elapsed they have held two meetings to carry out the terms of their reference, irrespective of what has been done by a special sub-committee formed to consider certain details.

The committee recommend that a working or executive committee (elected annually by the general body of the trade in accordance with the bye-laws of the Chamber) be charged with the ordinary business of the section, and that in the first instance it consist of 33 members, this

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number to be increased to 48 at the first annual meeting of the section, if the membership then obtained should warrant a larger representation.

It is proposed that the working committee should meet whenever occasion requires, and that meetings of the whole or part of the section, in addition to the usual annual meeting, should also be called from time to time.

With a view to an equitable representation on the working committee of the various branches of the electrical trade, the organising committee, after preparing a classified list of members, recommend that the committee be divided into the following sub-sections, viz.: (1) telegraph companies, 5 members; (2) telephone companies, 3 members; (3) electrical supply companies, 6 members; (4) electrical manufacturers and contractors, 13 members; (5) consulting electrical engineers, 4 members; (6) general, 2 members; Total, 33.

The committee recommend that members of the working committee be elected by ballot, and they have accordingly approved the issue of a voting paper with the circular convening the present meeting. They suggest that the election of the chairman and two deputy-chairmen of the section should rest with the working committee.

Having regard to the bye-laws and regulations of the Chamber, the committee do not advise the adoption of special rules to govern the section and its committee, as they are of opinion that for the present it will suffice to follow the procedure of other trade sections. As regards application for admission into the section, it is suggested that the working committee should be allowed an opportunity of scrutinising these before presentation to the council of the Chamber for election.

The committee further recommend that the questions first dealt with by the section and its working committee should include the most pressing of the matters set forth in the circular letter of the 24th of July last, and that the admission of reporters to all future meetings be determined by the vote of members present.

List of Electrical and Allied Trade Members of the London Chamber of Commerce.

Telegraph Companies.

Anderson, Sir James (Eastern Telegraph Company, Limited).
Andrews, W. S. (Indo-European Telegraph Company, Limited).
Anglo-American Telegraph Company, Limited.
Davies, Capt. W. H. (Exchange Telegraph Company, Limited).
Draper, Geo. (Eastern Telegraph Company, Limited).
Earle, C. W. (West India and Panama Telegraph Company, Limited).
Eastern Telegraph Company, Limited.
Gray, Robert Kaye (Spanish National Submarine Telegraph Company, Limited).
Indo-European Telegraph Company, Limited.
Mancha, J. de (Cuba Submarine Telegraph Company, Limited).
Pender, Sir John (Eastern Telegraph Company, Limited).
Tritton, J. Herbert (Indo-European Telegraph Company, Limited), Vice-President of the Chamber.
Tweeddale, the Marquis of (Eastern Telegraph Company, Limited).
Western and Brazilian Telegraph Company, Limited.

Telephone Companies.

Anglo-Portuguese Telephone Company, Limited.
Brand, J. (United Telephone Company, Limited).
Grewing, H. (Telephone Company of Austria, Limited).
Jackson, Col. R. Raynsford (National Telephone Company, Limited).
Lewis, H. F. W. (Western Counties and South Wales Telephone Company), Bristol.
Oriental Telephone Company, Limited.
Thompson, J. (Lancashire and Cheshire Telephone Exchange Company, Limited), Manchester.
United River Plate Telephone Company.
United Telephone Company, Limited.

Electricity Supply Companies.

Bailey, Frank.
Brougham, the Hon. Reginald T. D.
Crawford, the Earl of (London Electrical Supply Corporation, Limited).
Elieson, C. P. (Elieson Electric Company, Limited).
Erskine, R. S. (Kensington Court Electric Light Company, Limited).
Gordon, J. E. H. (Whitehall Electric Light Company, Limited).
House-to-House Electric Light Supply Company, Limited.
Ince, Francis.
Macpherson, Robt. (Electraction Company).
Martin, J. Browne (Westminster Electric Supply Corporation).
Massingham, H. G. (Taunton and Exeter Electric Light Companies, Limited), Bath.
Parker, Mark (Chatham, Rochester and District Electric Light Company, Limited), Rochester.
Wallace, Roger (Kensington Court Electric Light Company, Limited).
Wade, Arthur F.
Waller, Charles B., Major.
Webber, C. B., Major-General, R.E. (Chelsea Electric Supply Company, Limited).

Electrical Manufacturers and Contractors.
(And dealers in electrical supplies).

Allbright, J. F.
Allen, J. (F. Allen and Sons).
Allpress and Belshaw.
Anderson Brothers.
Anderson, J. H. (Anderson, Anderson, and Anderson).
Angus, George, and Co.
Applegarth, R.
Appleton, Burbey, and Williamson.
Bailey and Grundy.
Barter, Charles (Blockley Electric Lighting and Manufacturing Company, Limited), Blockley

Electrical Manufacturers and Contractors (continued).

Bayley, H. (Bayley Brothers), Walsall.
Berry, E. L.
Berry, F. H. (United Electric Wire Company).
Binswanger, G. (G. Binswanger and Co.)
Birnie, Joseph.
Birnie, W. J. (Joseph Birnie and Son).
Blackburn, A. B. (Edison and Swan Electric Light Company, Limited).
Black, Hawthorn, and Co., Gateshead.
Braby, F. (Frederick Braby and Co., Limited).
Buller, Johnson, and Co.
Cadiot and Espir.
Callender and Sons.
Cannon, F. W. (Carlton Engineering Company).
Clarke, Chapman, Parsons, and Co., Gateshead.
Cooper, Sir Daniel (Electrical Power Storage Company, Limited).
Courtenay, J. I. (Electrical Power Storage Company, Limited).
Crompton, R. E. (R. E. Crompton and Co., Limited).
Dennis, W. F. (W. F. Dennis and Co.).
Dowsing, H. J. (R. E. Crompton and Co., Limited).
Drake and Gorham.
Duncan, J. H. (Australasian Electric Light and Power Company).
Edison and Swan United Electric Light Company, Limited.
Electrical Power Storage Company, Limited.
Elliott Brothers.
Elwell-Parker, Limited, Wolverhampton.
Fells, J. M. (Anglo American Brush Electric Light Corporation).
Garcke, Emile (Anglo-American Brush Electric Light Corporation).
Glover, Walter T., and Co.
Goolden, W. T., and Co.
Hardt, P.
Harold, H. C. (Harold and Jenkins).
Hartnell, Wilson, Leeds.
Henley's (W. T.) Telegraph Works Company, Limited.
Hodd, R., jun. (R. Hodd and Son).
Hornsby, Rd., and Sons, Limited.
Hoster, Albert.
Howard, F. G.
Howell, J. C., Llanelly.
Immisch, Moritz (Immisch and Co.).
Johnson, J. G. (Johnson and Sons).
Johnson, Matthey, and Co.
Johnson and Phillips.
Jones, W. E. (Bayliss, Jones, and Bayliss).
King, J. W.
Kingsbury, J. E. (Western Electric Company).
Kirk (Wheatley), Price, and Goulty.
Koerber, Adam.
Laing, Wharton, and Down.
Loeffler, J. C. L. (Siemens Bros. and Co.).
Lundberg, A. P.
McDowell, R. W. H.
Marshall, H. D. (Marshall, Sons, and Co., Limited), Gainsborough.
Merriam, L. P. (British Xylonite Company, Limited).
Merryweather, J. C. (Merryweather and Sons).
Mordey, W. M. (Anglo-American Brush Electric Light Corporation, Limited).
Mountain, M. (Gülcher Electric Light Company).
Nicholson and Jennings.
Paris (Laurence) and Scott, Limited, Norwich.
Paterson and Cooper.
Pell, B.
Phillips, C. H. (Phillips Bros.)
Phosphor Bronze Company, Limited.
Price, Sons, and Co., Bristol (represented by C. Dexter Barker).
Raworth, J. S. (Anglo-American Brush Electric Light Corporation).
Reeves, F. R. (R. E. Crompton and Co., Limited).
Reid, Jas. (Reid Bros.).
Robinson, Mark H. (Willans and Robinson, Limited).
Schmidt, F. T. (the Schmidt-Douglas Electric Company, Limited), Hustlergate.
Sharp and Kent.
Siemens, Alex.
South, Harry.
Spence, J. B. (J. Berger Spence and Co.).
Stephens, John (Stephens, Smith, and Co.).
Strode and Co.
Thompson, A. (Thompson and Ritchie).
Torrington, Viscount (R. E. Crompton and Co., Limited).
Trench, Col. the Hon. W. Le Poer (Edison's Indian and Colonia Electric Company, Limited).
Verity Bros.
Villiers (Frank), Stead, and Co.
Warne, Wm., and Co.
Willey, John (London Electric Wire Company).
Williams, E. Pascoe (Merryweather and Sons).
Woodhouse and Rawson, Limited.
Wright, J. (Schanschieff Electric Syndicate).

Consulting Electrical Engineers.

Abel and Imray.
Adams, J. D. (Adams and Son).
Alabaster (H.), Gatehouse and Co.
Beldam, A.
Bewick and Moreing.
Biggs, C. H. W.
Canning, Sir Samuel.
Churchill, J. D. (Durham, Churchill, and Co.),
Clark, Forde and Taylor,
Cundall, J. H,

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Consulting Electrical Engineers (continued).

Ewens, Paul.
Fell and Wilding.
Forbes, George (Professor).
Fox, St. George Lane.
Fricker, Guy C.
Grindle, Geo. A.
Heaphy, Musgrave.
Hill, Pearson.
Kapp, Gisbert.
Lea (Hy.) and Thornbery, Birmingham.
Maxim, H. S.
Mewburn, John Clayton.
Preece, W. H. (G.P.O.).
Price, Hy. Sherley (Wheatley, Kirk, Price, and Goulty).
Reckenzaun, Anthony.
Snell, W. H.
Spagnoletti (J. E.) and Crookes.
Trotter, A. P.
Wise, W. Lloyd.

General.

Appleby, C. J. (Appleby Bros., Limited).
Bolling, F. (Bolling and Lowe).
Brooke, C. B. (Phelps, James, and Co.).
Brooker, E. G. (Brooker, Dore, and Co.).
Bullivant, W. M. (Bullivant and Co.).
Burroughs, S. M. (Burroughs, Wellcome, and Co.).
Burt, J. H. (J. H. Burt and Co.).
Dore, S. L. (Blackwall Galvanised Iron Company).
Ellis, B. P. (J. Aird and Sons).
Firth, Thomas, and Sons, Limited.
Fraser, G. C. (Fraser and Fraser).
Gibbons, James (Tyndale, Gibbons, and Co.).
Gordon, Alex.
Hogg, Quintin (Hogg, Curtis, and Campbell).
Tyrer, Thos. (May and Baker).
Von Glehn, E. (Ragosine and Co.).
Wellcome, H. S. (Burroughs, Wellcome, and Co.).
Macgregor, Alex.
Salomons, Sir David, Bart., Broomhill, Tunbridge Wells.
Voelcker, Dr. Augustus, and Sons.

Where no address is placed after the names it is to be understood that it is in London.

TELEPHONIC COMMUNICATION.

The following discussion on this subject took place at the autumnal meeting of the Association of the Chamber of Commerce, recently held at Cardiff.

Colonel A. Robson (Sunderland) moved: "That the Executive Council be requested to urge upon the Government the advisability of reducing the rental charged for the use of telephones." One argument in favour of the proposal would, he thought, carry the Chambers with him in spite of all opposition, and that was, that it was a direct appeal to their pockets. The charges for telephonic communication in this country were higher than in almost any other country, and there were two ways in which those charges might be reduced; by the Government reducing the charges for the use of Government telephones, and by the reduction of the royalty charged upon the use of telephones by private companies. The Government telephones were at present very little used indeed, which seemed to be due to the fact that the rates of subscription were too high. If those rates were reduced there could be little doubt that the use of Government telephones would extend itself in the future. The royalty upon the rental charged by private companies ought also to be diminished, as the imposition of 10 per cent. on the rental charges was, in their opinion, too heavy. It was the conviction of his Chamber that, taking into account the interests of the commercial community, 5 per cent. would be a sufficiently heavy royalty, and if the royalty could be reduced to that limit doubtless benefit would accrue in diminished rental charges, as well as in more extended use of the telephone.

Mr. J. Richardson (Stockton-on-Tees) seconded the resolution, observing that there was one argument the mover might have urged, as the Post Office was a very profitable concern to the Government, and that was that the Government could afford to be liberal in developing the use of the telephone in this country. The telephone was a very great convenience indeed, but the charges imposed for its use were not only excessive but prohibitive. The cost of instituting telephonic communication also depended upon the distance over which the wires had to be carried, and in his own case it had suited the convenience of the Government to lay the wire not "as the crow flies" but over a roundabout course, and extending over an unnecessarily long distance. He hoped the executive council would look into the question, for he was quite sure that the telephone system was now one that they could not do without.

Mr. Wm. M'Gryllis (Falmouth), in supporting the resolution, said in his office, in the town of Falmouth, within 500 yards of the post-office, which had a large staff of telegraphists, and was second to none in the west of England, dealing with 150,000 telegrams in a year, he had been charged £15 per year for the use of a telephone wire. He thought they might very fairly go to the Post Office authorities and say, "You should enable the public to avail themselves of these facilities at the lowest possible charges." It was only fair to say that that charge of £15 to which he had referred had now been reduced to one of £12 per year, but they still thought there was room for further reduction so that the general public might be more fully accommodated and the work of the Post Office might be increased.

Mr. J. T. Belk (Middlesbrough): The last speaker has stated that he paid £15 per year for a wire extending over 500 yards. I do the same for a telephone wire going simply through a 9in. brick wall.

Mr. A. Groser (Plymouth) thought the remedy was very much in their own hands. In Plymouth they had been in the same difficulty some years ago, until they invited the United Telephone Company to come to their rescue. The result had been, the Post Office still adhering to their abnormal charges, that they now had telephonic communication throughout the three towns—Plymouth, Devonport, and Stonehouse—included in their district at the rate of £10 per head per annum, for any place within that district. If the same course were adopted in other districts, they would obtain all they desired in the way of improving and reducing the cost of telephonic communication.

The **President**: I had the honour of introducing a deputation to the Postmaster-General upon this very subject, and we were then told that the matter had by no means escaped the attention of the Post Office, but that the moment was not favourable for considering the subject, because the patents were about to expire in 12 or 15 months. Until these events had taken place it was not possible for the department to give the subject that attention which they desired. This resolution will help to stimulate the department to carry out our views, and I think we may fairly hope so, because the Chambers feel that Her Majesty's Postmaster-General, and the department generally, have always shown a disposition to do what they could to meet the wishes of the commercial classes.

The resolution was carried unanimously.

ELECTRO-HARMONIC SOCIETY.

Programme of the Electro-Harmonic Society's First Smoking Concert (third season), to be held at St. James's Hall Restaurant (Banquet Room), Friday, the 26th October, 1888. Artistes: Mr. J. A. Brown, Mr. Arthur Thompson, Mr. W. G. Forington, Mr. Robert Hilton. Solo Violoncello, Monsieur Albert. Solo Pianoforte and Accompanyist, Mr. Alfred Izard. Musical Directors, Mr. T. E. Gatehouse and Mr. Arthur Thompson. A Broadwood piano will be used. Doors open at 7.30; commence at 8 o'clock.

PART I.

Part Song ...."A Festal Greeting".....Mendelssohn.
Canzonetta .. .."Tre Giorni Son Che Nina"..... Pergolesi.
Mr. Arthur Thompson.
Song .. .."The Night Watch"..... Pinsuti.
Mr. W. G. Forington.
Solo Violoncello....."Fantaisie Originale".. ..... Albert.
Monsieur Albert.
Glee ....."Amo Amas" (The Pedagogue's Song)..... Shield
Recit. and Air ..... ("I rage, I melt, I burn" / "O ruddier than the cherry")..... Handel.
(Acis and Galatea)
Mr. Robert Hilton.
Part Song ....."Lovely Night".....Kucken.

PART II.

Part Song....."Come, boys! drink and merry be"..... Marschner.
Solo Pianoforte....."Etude D flat"..... Liszt.
Mr. Alfred Izard.
Song ...."The Meeting of the Waters"..... Moore.
Mr. Arthur Thompson.
Solo Violoncello.....(a "Berceuse" ..... Gounod. / b "Chacone"..... Durand.)
Monsieur Albert.
Song ....."The Snowy Breasted Pearl"...Old Irish Melody.
Mr. W. G. Forington.
Song..... .. .." Out on the Deep "..... . .....Löhr.
Mr. Robert Hilton.
Catch....." Would you know my Celia's Charms".....Webbe.
Finale ...." Good Night" ..... Hatton.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts of this Company for the week ended October 12 amounted to £5,061.

South of England Telephone Company.—The Directors of this Company at a meeting, held on the 11th inst., elected Mr. Charles Billett, of Copthall-buildings, E.C., to a seat at the board, in place of Mr. T. F. Campbell, deceased.

Western and Brazilian Telegraph Company.—The traffic receipts of this Company for the week ending October 12, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £4,215.

Direct United States Cable Company.—The Directors announce an interim dividend of 2s. per share free of income-tax, being at the rate of 2 per cent. per annum, for the quarter ending September 30, such dividend to be payable on and after the 24th inst.

Anglo-American Telegraph Company.—At a meeting of the Board of Directors of this Company, held on Friday last, it was resolved to declare an interim dividend for the quarter ending Sept. 30 of 7s. 6d. per cent. on the ordinary stock, and 15s. per cent. on the preferred stock, less income-tax, payable on November 1 to the stockholders registered on the books of the Company on the 9th inst.

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PROVISIONAL PATENTS, 1888.

OCTOBER 5.

14,322. **An improved galvanic cell or battery for electric lighting or for other purposes.** Samuel Miller, 43, Southampton-buildings, Chancery-lane, W.C.

14,323. **An improved electrolyte or depolarising solution for galvanic batteries.** Samuel Miller, 43, Southampton-buildings, Chancery-lane, W.C.

OCTOBER 6.

14,383. **An improved electric switch.** Joseph Hauser, 97, Newgate-street, London.

OCTOBER 8.

14,426. **Improved electrical connection.** Charles Scott Snell, Culver Park, Saltash, Cornwall.

OCTOBER 9.

14,456. **Improvements in telemotor apparatus or apparatus for working steering, telegraphing, indicating, and other apparatus from a distance.** Andrew Betts Brown, 87, St. Vincent-street, Glasgow.

14,489. **Improvements in electric lighting.** Eugen Ritter von Nollendorf, 28, Martin's-lane, Cannon-street, London, E.C.

14,492. **Improvements in electrical signalling, indicating or registering apparatus for railway purposes.** John Bruce Sutherland, 45, Southampton-buildings, London. (Complete specification.)

14,499. **Electric light switches.** Howard Swan, 140, Salisbury-court, Fleet-street, London, Middlesex.

14,522. **Improvements in galvanic batteries.** David Humphreys, 226, High Holborn, London. (Complete specification.)

OCTOBER 10.

14,542. **Improvements in electric and other bells.** Reginald Wilmot Hayes Newington, 42, Bath-road, Bedford Park, Chiswick, W.

OCTOBER 11.

14,600. **Improvements in the cores and armatures of electric bells, relays for electric bells, railway signalling bells, and electrical indicators.** George Henry Bassano, 38, Warner-street, Derby.

14,612. **A marine telpherage system.** Joseph Monteith, 62, St. Vincent-street, Glasgow.

14,622. **Variable adjustable resistance for electrical currents.** Ernest George Craven, 4, Little Moorfields, E.C.

COMPLETE SPECIFICATIONS ACCEPTED.

OCTOBER 27, 1887.

14,632. **Improvements in electrically lighting railway trains.** Illius Augustus Timmis, 2, Great George-street, Westminster, S.W.

NOVEMBER 7, 1887.

15,161. **A coin-freed electrical current-producing apparatus.** Percival Everitt, 4, South-street, Finsbury, London.

NOVEMBER 16, 1887.

15,735. **Improvements in electrical indicating or signalling apparatus.** William Robert Lake, 45, Southampton-buildings, London. (Claude Grivolas, France.)

NOVEMBER 28, 1887.

16,324. **Improvements in electro-mechanical striking gongs.** Frederick Thomas Schmidt, 27, Highfield-lane, Keighley, Yorkshire.

DECEMBER 8, 1887.

16,870. **Improvements in electro dynamic generators and motors.** Roger Tatham, 4, Clayton-square, Liverpool.

DECEMBER 10, 1887.

17,031. **Improvements in or relating to the regulation of electric currents and in apparatus therefor.** Wilhelm Lahmeyer, 18, Buckingham-street, Strand, London.

DECEMBER 17, 1887.

17,409. **Improvements in electrical primers or fuses.** Charles Ambrose McEvoy, The London Ordnance Works, Bear-lane, Southwark, Surrey.

JANUARY 17, 1888.

729. **Improvements in electric batteries and elements therefor.** David Urquhart, 47, Lincoln's-inn-fields, London.

AUGUST 28, 1888.

12,396. **Improvements in electric motors for self-winding clocks.** William Phillips Thompson, 6, Lord-street, Liverpool. (Daniel W. Edgecomb, United States.)

12,437. **Improvements in electrical conductors or cables.** Wm. A. Conner and Joseph W. Marsh, 55 and 56, Chancery-lane, Middlesex.

SEPTEMBER 11, 1888.

13,128. **Improvements in electric railway signalling systems.** Joseph Irwin, 226, High Holborn, London, W.C.

SEPTEMBER 12, 1888.

13,193. **Bleaching paper pulp by electrolysis.** Emile Marie Hippolyte Andreoli, 62, Loughborough-park, Brixton, S.W., Surrey.

SPECIFICATIONS PUBLISHED.

1887.

12,418. **Conveying electric energy, &c.** S. Z. De Ferranti. 11d.
12,419. **Electric railways.** S. Z. De Ferranti. 11d.
12,437A. **Electrical measuring instruments.** R. E. B. Crompton and J. Swinburne. 8d.
13,154. **Controlling cocks and valves by electricity.** H. R. Fisher. 8d.
13,561. **Electricity meters.** H. W. Kolle. 6d.
14,226. **Measuring electric currents.** M. J. R. Jacquemier. 1s. 6d.
15,158. **Electric safety lamps.** J. Sinclair and J. P. Rees. 8d.
15,939. **Electrolytic treatment of sewage, &c.** W. Webster. 8d.
16,087. **Electric contact-maker for coin-freed apparatus.** J. S. Farmer. 8d.
18,030. **Thermo-electric batteries.** L. C. E. Lebiez and P. L. Verchere. 8d.

1888.

3986. **Plates for secondary voltaic batteries.** B. M. Drake and J. M. Gorham. 8d.
5586. **Electric incandescent lamps.** H. H. Lake (Grivolas). 8d.
11,403. **Propelling vehicles by electricity.** H. H. Lake (Weis). 8d.
11,705. **Measuring electric currents, &c.** W. P. Thompson. (The Westinghouse Electric Co.) 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	4¼
12 Feb.	2/0	— fully paid	5	5¼
27 July	1%	Anglo-American	100	48½
27 July	2%	— Pref.	100	80½
12 Feb., 85	5/0	— Def.	100	17¼
28 June	3/0	Brazilian Submarine	10	13½
14 June	1/0	Con Telephone & Main	1	1/16
10 Aug.	9/0	Cuba	10	14
10 Aug.	10/0	— 10% Pref.	10	18½
12 Oct.	2/0	Direct Spanish	5	4
12 Oct.	5/0	— 10% Pref.	5	10¼
27 July	2/0	Direct United States	20	10¼
12 Oct.	2/6	Eastern	10	12⅝
12 Oct.	3/0	— 6% Pref.	10	15¼
1 Aug.	5%	— 5%, 1899	100	110
26 April	4%	— 4% Deb. Stock	100	110
12 July	2/6	Eastern Extension, Australasia & China	10	13 1/16
1 Aug.	6%	— 6% Deb., 1891	100	104½
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	105
28 Mar.	8/8	German Union	10	9½
12 Oct.	3/0	Globe Telegraph Trust	10	7½
12 Oct.	3/0	— 6% Pref.	10	14½
30 April	5/0	Great Northern	10	14
1 March	5%	Gt. Northern 5% Deb., '83.	100	103½
27 July	10/0	India Rubber, G. P. & Tel.	10	17 1/16
11 May	37/6	Indo-European	25	39½
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅜
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
		Swan United	3½	2¼
10 Aug.	13½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	98
12 July	4/0	West Coast of America	10	8
30 June	8%	— 8% Debs.	100	115
11 May	9/0	Western and Brazilian	15	12⅝
11 May	6/10½	— Preferred	7½	7½
11 May	2/1½	— Deferred	7½	5½
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	1½
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80		— 6% 2nd Pref.	10	10⅝
2 May	7%	West Union of U.S.	$1,000	125
1 Mar.	6%	— 6% Sterling	100	102

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NOTES.

Hendon.—Hendon is enquiring about the price paid for electric lighting.

Electric Omnibuses.—Omnibuses driven by power from accumulators are said to be running for conveyance of passengers in Paris.

St. Olave's.—The estimate received for lighting the parish with electric light was stated at the last board meeting as £1,300 per annum.

Nuremberg.—The central railway station of Nuremberg is being lighted with 33 arc lamps of 3,000 c.p. and 30 small arc lamps of 450 c.p.

Zipernowski System.—Messrs. Ganz and Co. have carried out 147 central installations on the transformer system during the last two years.

Sprague.—The Sprague Company have started another electric railway last week in Akron, Ohio. It has twelve cars and is six and a-half miles long.

Telephone Induction.—Telephone troubles, usually attributed to induction, are quite probably directly attributable to small actual ground connections.

Arc Cut-Off.—An automatic cut-off is used by an American electrician, by which, when the lamp is to be cleaned, the circuit is automatically broken by the act of lowering.

Personal.—We understand that Mr. A. A. Campbell-Swinton has accepted the position of consulting electrical engineer to Messrs. Sir W. G. Armstrong, Mitchell, and Co., of Elswick.

Importation of American Plant.—We learn that a large quantity of American electrical plant is weekly imported from the United States to Liverpool for delivery to various parts of England.

Ipswich.—The application of Messrs. Laurence, Paris, and Scott, Limited, for permission to lay underground cables for the distribution of light and power, was brought before the Ipswich Paving Committee, but was discussed in private.

Herne Bay.—The town of Herne Bay is to be lighted by a 20,000 c.p. arc light plant, on the Waterhouse system. The contract has been placed in the hands of Messrs. Shippey Brothers, Limited, by the Herne Bay Electric Light Company.

Institution of Civil Engineers.—There has just been issued a new list of the members of this association, which, in point of numbers, is probably the largest of any voluntary society—the roll of its members, associate-members, associates, and students aggregating 5,529.

Arts and Crafts.—The electric lustre seen on entering the centre hall of the Arts and Crafts Exhibition at the New Gallery was supplied by Veritys, of King-street, Covent Garden. It is a 78-light massive and handsome pendant in wrought scroll brass, with moulded glass shades.

Bismarck's Telegraph Poles.—It appears that the telegraph poles of the German Empire are largely, if not exclusively, obtained from the forests of Prince Bismarck's estate at Friedrichsruh. The despatch of the 100,000th pole has been recently celebrated there with great festivities.

Long Distance Telephoning.—Philadelphia is now connected with Portland (U.S.), a distance of 450 miles, and words are heard quite distinctly. Philadelphia, New York, Brooklyn, Albany, New Haven, Providence, Boston, and Portland, with intermediate towns, are now all connected.

Brussels.—At the exhibition, which is announced to close on Nov. 5, the following honours have been awarded to firms connected with the electrical industries. The Electrical Power and Storage Company has received a gold medal, and the Anglo-American Brush Corporation a diploma of honour in Class 47 (Electricity).

Our Register.—We insert this week the first instalment of our register of capable men wanting appointments. The register is more or less of an experiment to test the usefulness of such a list as between the men and the employers of skilled labour, and no charge is made, for the present, for entry on the list. But if the field of usefulness increases, as we think probably it may, a small charge will have to be made for insertion.

Deafness Caused by the Electric Light.—A curious phenomenon was recently related by M. D'Arsonval before the French Academy of Medicine. After gazing for a few seconds on an arc light of intense brilliancy, he suddenly became deaf, and remained so for nearly an hour and a half. Surprised and somewhat alarmed in the first instance, but reassured by the disappearance of the symptoms, he repeated the experiment with the same result. When only one eye was exposed to the light, no very marked effect was produced.—*Medical Press.*

Ancient Incandescent Lamps.—Mr. Shippey has a collection of original incandescent lamps at 13 and 14, King-street. An original Woodward lamp, made in the States in 1874; a sample of the Peabody lamp, which is a lamp made under Edison's patent in 1879, and exhibited at Menlo Park; a lamp of Mr. J. W. Swan's, exhibited at Newcastle; also a Harrison lamp, exhibited at the Crystal Palace Exhibition of 1881 under Harrison's early patent. These lamps will be on view to anyone interested in the manufacture or history of incandescent lamps by appointment.

Yacht Lighting.—The contract for lighting the steam yacht "Nerissa," belonging to Mr. Ralli, a private Greek gentleman, has been awarded to Mr. F. Geere Howard. The electrical plant will be supplied complete, separate boiler, engine, with dynamos and set of accumulators, from beginning to end, entirely independent of the ship's machinery, and is specially interesting in this respect. The installation will consist of sixty incandescent lamps, with probably a search arc light for the front. The same contractor has also carried out the lighting of the steam yacht "Warrior," for the Egyptian Government, and also the "Geralda," for Captain Hamilton.

Notes on Installations.—We invite our readers attention to the continuation of the articles on installations in this number, which will be continued, making it as complete as possible with reference to the details likely to beset the young engineer in putting down electric light plant, touching on the proportions of dynamos, choice of motors, direct coupling, belting, friction gearing, sliding beds, jockey pulleys, kinds of belts, lubrication, dimensions of pulleys, fly-wheels, governors, running leads, diameter of leads, insulation, cut-outs, switches, casing, loss of E.M.F. in leads, switchboards, instruments, transformer systems, accumulators and their management, coupling dynamos in series and parallel, regulation of arc lamps, carbons, &c. This set

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of practical articles will, we believe, prove very useful to electrical engineers.

City Lighting.—At the last meeting of the Commission of Sewers, the chairman (Mr. Pannell) said there were before the commission six or seven applications from electric lighting companies who were desirous of lighting a portion or the entire area of the City. These applications had been referred to the Streets Committee, and the solicitor and engineer had been instructed, in conference with Mr. W. H. Preece, F.R.S., to prepare for the purposes of the committee a scheme on which could be based a form to be advertised, so that they might receive tenders not only from these companies, but from any other corporation that might desire to tender for any area of the City. In order to avoid a former error, the commission thought that before they invited tenders they should themselves be in a position to decide the lines on which such applications should be made.

A Finger-Ring Current Indicator.—Persons in charge of electric light stations, and especially linemen, frequently have occasion to determine whether wires which they are handling carry current or not—in other words, whether they are "dead" or "live"; and, as there is no handy method of determining this ordinarily, some simple means of doing so is of considerable value in many cases. To meet this want, says the *Electrical World*, Mr. Patrick B. Delany has recently devised a simple arrangement, in the shape of a ring, which is worn by the operator, and which contains a small compass needle. By placing the ring in proximity to a wire, the deflection of the needle will at once show whether the wire be carrying current or not. Another method consists in filling the bezel of the ring with iron filings, the attraction of which, by the action of the current, also serves to show the presence of the same.

Government Lights.—Last Monday, says the London correspondent of the *Sheffield Telegraph*, Sir Richard Webster gave a dinner party, which was attended by the counsel who are with him in the *Times* case, at his house in Kensington. The Attorney-General, who first won fame at the Bar in patent cases, has his house in town and his seat in Surrey alike fitted with the electric light and other new appliances. Indeed, he was a pioneer in electric lighting for domestic purposes, his residence in Kensington being one of the first London houses in which the electric light was installed. But the present Government is largely composed of "electric lighters." Lord Salisbury uses the new light both at Hatfield and at Arlington-street, the effect in both instances being very fine. Mr. Smith, again, went to vast expense a short while ago to install the incandescent light in his handsome house in Grosvenor-place. Mr. Akers-Douglas, who dabbles in practical engineering when he has a little leisure, has worked wonders with the electric light at his seat, Chilton Park, in Kent.

Dublin.—At the last meeting of the Dublin Corporation the question of electric lighting was discussed, and Mr. Robinson, who stated that the time had come when some practical step should be taken, moved "That the town clerk and the law agent be directed to issue the necessary advertisements and take the proper steps, under the Electric Lighting Act of 1882, to obtain a provisional order authorising the corporation, as the local authority, to supply the electric light for private and public purposes," which motion was seconded by Mr. Healy, and adopted by a large majority of the council. Mr. Robinson then moved: "That a committee be appointed with all the necessary powers to apply for a provisional order, and do all necessary acts, subject to the approval of the council," when Mr. Doherty moved an amendment: "That the appointment of the committee be deferred until after the discussion on the report of the committee of the whole house on the subject of electric lighting." The amendment was rejected, and the resolution, on being put to the meeting, was adopted by a large majority.

Leeds.—Applications from electrical engineers and companies have been received lately by the Leeds Corporation, asking for the privilege of establishing in particular districts the electric light. In these cases, the necessity for carrying wires across or along the highways has caused the applications to come before the Highways Committee. The applicants would not be bound to do as the corporation *itself*, or any company obtaining a provisional order would by Act of Parliament be required to do—viz., to supply to all persons requiring the light; and their intention is to supply only a limited number. The Highways Committee therefore have not deemed it right at once to sanction the applications. The whole subject of electric lighting in Leeds will shortly be brought before the town council, for the special work of the Electric Lighting Committee has come to an end, they having exhausted their powers and their money. Last week they instructed the borough engineer, Mr. Hewson, to prepare a scheme for lighting a sectional area of Leeds—starting (say) with the principal streets—Briggate, Boar-lane, and Commercial-street, and supplying the electric light to all shopkeepers and others who may require it.

Coal Premium.—A system of securing the practical co-operation of firemen in the interests of the concern they are engaged in, recently introduced with considerable gain upon some of the railway lines, might prove successful in the various electric light installations to induce care and economy in firing. This is the "coal premium" plan. The allowance of coal necessary as fuel for an engine is placed at a certain amount. If an engineer and fireman fill the requirements of the schedule with a less amount, they are paid half the value of the coal saved. If they exceed the allowance, they are not charged with the excess, but their conduct of an engine is examined with a view toward improvement. The full efficiency of an engine, as engine-makers well know, is only secured with intelligent and hearty co-operation of the fireman, so that the "efficiency" of the fireman is an important item, and the extreme of efficiency of any man is best secured by giving him some direct interest in his best endeavours. Managers can ascertain the lowest amount of coal used on the old system, and anything below this, by extra attention, would be clear gain, a proportion of which could evidently be assigned to the men without loss.

The Brush Company.—The information that we have given in recent issues as to briskness of business is fully confirmed by the action of the Brush Company, from whose advertisment it would be gathered—but we have it also from other sources—that they are so pressed with orders for incandescent lamps as to be compelled to inform customers that until the completion of their extended lamp factory orders can only be executed in the rotation received. We are informed that the new lamp of this company is giving great satisfaction, both a to economy of

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current and length of life. It may be remembered that we have once or twice alluded to pending negotiations for the construction of an electrical tram line on the Continent, and we believe the contract has now been signed, and it may be taken that this contract is only preliminary to others now under consideration. The corporation are also very busy, not only with orders for independent installations, but with dynamos and other electric apparatus for export, and for their new central stations, and we have little doubt but that the favourable light in which the corporation is now regarded in City circles, and which is manifested by the rise in the market value of the shares, is completely justified.

Technical Institutes.—The Goldsmiths' Company have given what practically amounts to the sum of £85,000 for the purpose of founding a Polytechnic Institute at New Cross. Battersea and Newington are yet unprovided for, and the *Pall Mall Gazette* points out that the ill-fated Albert Palace is for sale, and thinks a more suitable building and site for the purpose could not well be imagined. It could be obtained for about £60,000, and if the Government would present the ground less than half this amount would be required. The action of the Goldsmiths' Company is a noble and generous one, and it may well be hoped that the other companies will follow suit in their appreciation of technical education. Leaving out the Drapers and Goldsmiths' Companies, the total corporate income in 1880 of the other ten great companies amounted to £250,000, and the trust income to £100,000. A little more appreciation of the real technical educational work so successfully carried on at the Finsbury College, but hampered for want of funds, would not be out of place at this juncture. Those interested in technical education should never forget that the Finsbury Institute was in reality the first true step in England in the direction of actual technical education on an extended scale, and our pride as Englishmen, as well as our appreciation of the benefits of such work in the commercial life of this country, should lead us to make our first institutes models, in all respects, of what is necessary for the spread of practical technical education.

Central Station at Interlaken.—The well-known Swiss town of Interlaken, in the Bernese Alps, at the foot of the Jungfrau, has had since July last a central electric lighting station for arc lamps some interesting particulars of which are given in last week's *Centralblatt fur Electrotechnik*. The installation is worked by water-power from a Jonval turbine giving about 40 to 45 h.p., and will supply 70 arc lamps, taking 10 amperes, or a proportional number taking 5 amperes, and over 50 are at present in use. The direct current system is employed at a pressure of 400 volts, and the lamps are run on a kind of parallel-series arrangement, the district extending to some distance on each side of the station. Seven lamps are run in series, taking 10 amperes and 50 volts each, making 350 volts, about 50 volts being allowed for loss on leads and resistances. There are up to the present six groups of seven lamps each, equal to 42 10 ampere lamps; some of these lamps are run two in parallel, 5 amperes each—the total number in use is about 50 lamps. Bare overhead wires for the most part are used, run on iron poles on the roof, or on high wooden masts. Nearly every hotel has the light for its table d'hote, and 16 boarding establishments are fitted with 10 ampere or a pair of 5 ampere lamps in their dining saloons; and the lamps are used in the gardens of the principal hotels in the Kurgarten, and in the streets and squares hung in wrought-iron pendants and brackets. The installation was carried out by R. Alioth and Cie., of Basle, for the gas and water company of Interlaken. The whole installation is supplied from a single dynamo, one of this firm's "Helvetia" machines, compound-wound, giving 70 amperes and 400 volts at 380 revolutions.

Philadelphia Subways.—After a long investigation of the numerous cheap conduit systems, the telegraph and telephone companies of Philadelphia have determined to adopt an expensive but satisfactory one of their own, believing that it will prove the cheapest and best in the end. The conduit will be built in brick eight feet high and four feet wide along the main streets and avenues, and in this will be 50 three-inch iron pipes, for 100 wires each, making 5,000 wires in all One connection only will be made with each block, a main running from the conduit and underneath the house line to the middle of the block, where, from the top of a tall pole, the wires will be run in mid-air to the rear of each house. The estimated cost of construction, it is said, will be £50,000. Powerful pumps will keep the conduit filled with dry air, and the main, being of sufficient dimensions, may be subjected to daily inspection throughout its whole length. It is not necessary on such a system to tunnel every main street, but at most every alternate one, as branch wires can be taken from each side to all the houses in one block; and the number of conduits could have been further reduced by branching, and it was probably only fear of complication that prevented the reduction of cost in this manner. The work is now fairly started, and a part is nearly complete. The reduction in necessary outlay for first cost by the use of a large conduit, of minimised length, may lead to reconsideration of conduit schemes in other parts of the world, for though the English towns are not laid out in the mathematical way of American cities, yet it is possible the conduit plan fails to recommend itself because too much of it is thought necessary. The Philadelphia experiment may, however, be looked to to furnish absolute practical data for the system of underground electric conduits in large towns.

Five Miles a Minute.—The Electro-Automatic Transit Company, of Baltimore, which is the owner of the Weam's electric postal railway patents, recently alluded to by us, are erecting, says the New York *Electrical Review*, an experimental track at Laurel, near the city of Baltimore, and are engaged in experimenting with a car of special construction. The motive-power for this road will be supplied by electricity, and the cars will be controlled and the brakes applied by the same power. Forty-five men are now busy joining the ends of the two mile circular track, finishing the generating house, and building the car house. Only one quarter of a mile of track remains to be laid, and the grading is finished. Each car is built of sheet iron, is 2ft. square, and about 21ft. long. Two cars constitute a train, and when so joined they are connected after the vestibule pattern by a flexible connection the size of the car itself. The rails are three in number, one above for carrying the current to the car, and two below constituting the return. The speed which it is expected to attain is five miles per minute. The motors for this road will be of a special type, and will be furnished by the Sprague Electric Railway and Motor Company, of New York. They will be of the most approved type of 25 guaranteed h.p. each, and especially adapted for this work. The power car will carry three motors, making 75 h.p. available for driving each train. Self-oiling bearings of special type will be used. The power is furnished by a 100 h.p. Ball

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engine. We shall be interested in the result of these preliminary experiments, which, if successful, will no doubt have a very important result. The chief difficulties with which the American experimentalists will have to contend are only two, but they are formidable. These are obtaining the peripheral speed of the motor and wheels, and overcoming the resistance of the air, both of which, at anything like the contemplated speed, are factors unknown and entirely unprovided for in any existent system of locomotion.

The Pullman Electric Railway.—The new electric line is in progress at Pullman. The system to be used will in all probability be a combination of various systems, as the object of the road is for experimental purposes as well as for affording transportation to the people who live along the route. A portion of the road is to be equipped for using the overhead system, while another portion will probably be furnished with an underground conduit, which, however, will not be laid at present, but can be later without interfering with the track. In this way the promoters of the different systems will be given a chance to show the efficiency of their system. The Pullman Company express the greatest faith in the future of electric street railways, and are increasing their facilities for manufacturing motor cars, which they intend to make a specialty. They will be enabled to build a motor car of any special design, equip it with a motor, and satisfactorily test it on their own road before it is sent to the purchaser. The Pullman Company believe that no electric railway system at the present time is absolutely perfect, but all are capable of further improvement, and they hope to be able to help in the development. With reference to the project for illustrating the advantages of each type of motor on the Pullman railway, this will, says the *Scientific American*, be the first really practical attempt to compare the various systems on the same line and under similar conditions. If the avowed purpose of the company may be accepted in good faith, and the projectors of the various systems will really assent to such comparative trials, we are likely to get at more cold facts concerning electro-motors than we have had for many a day. Those who may have watched unprejudiced the progress of the various systems of electrical locomotion will doubtless agree that each seems to have some special virtue in the way of economy or certainty of operation. And so it is to be hoped this wealthy manufacturing company is sincere in its promise to give each a fair trial. A four-mile line would seem to be adequate for the purpose, and the neighbourhood of large stationary engines a most convenient starting point.

Fleetwood.—The Lancashire sea-side towns are moving in questions relating to electric lighting, and several of them think of adopting the system. At Fleetwood an adjourned public meeting has been held to hear a report of the deputation which was appointed about a month ago to make enquiries as to the methods and cost of lighting in other towns. The deputation had made various enquiries, and reported upon the lighting of Leamington, which the committee said was a success so far as the lighting of the shops was concerned, but further improvements in the streets might be necessary. With reference to the lighting of Barnet, the installation of which is confined at present to street lighting and to one hotel, it was estimated that with gas, at the rate of 4s. per thousand, a similar light could be provided by means of electricity of equal candle-power to that of gas so as to ensure a profit of 20 per cent. on the capital expenditure required. The deputation also visited Messrs. Laing, Wharton, and Down, and Messrs. Shippey Bros. In the first case, Messrs. Laing, Wharton, and Down, previous to giving figures as to cost of plant, were required to inspect and survey the town, and Messrs. Shippey Bros. gave them information as the agents in England for the Waterhouse system, and stated that they would agree to establish a central station and provide all fittings if a sufficient number of tradespeople would undertake to rent the light. It was stated that this company was now under treaty to light the city of Norwich, and had just concluded arrangements for lighting Herne Bay. The report of the committee concluded with a recommendation that the offers of Messrs. Shippey Bros., to furnish complete estimates for electric lighting, be accepted. It was moved that the report should be received and adopted, and this resolution was carried. Subsequently another motion was moved: "That the Fleetwood Improvement Commissioners be requested to take into consideration the recommendations made in the report of the committee with a view to the introduction into Fleetwood of electric or some other light," and, after considerable favourable discussion, this motion was also put and carried unanimously.

The Southwark Subway.—Some few particulars of the Southwark Subway may be interesting in view of the recent decision to run the railway by electric traction instead of cable, as at first intended, although practical work has not begun, nor, we understand (contrary to reports that have been rumoured), is the contract arranged or the details of the scheme finally settled. Extensive trials will have to be undertaken by the contracting parties for an important scheme like the subway railway, where a three minutes' service will have to be kept up. But there is little doubt, at any rate, to those who know the capabilities of the electric system that sufficient and successful arrangements can be carried out by competent electrical engineers. The subway has been in course of construction for some considerable time, one tunnel having been first constructed under the bed of the Thames to prove the possibility of the plan. From this point a double tube of iron 10ft. in diameter has been laid to the Elephant and Castle. The two tubes are not side by side, but nearly over each other, coming to level again at the two termini. Just opposite the Monument is an apparently empty house, with a wooden swing-door, inside which the cautious visitor may look down into the depths of the earth (which yields a slightly sewer gas odour) into apparently an iron tank, some thirty or forty feet in diameter, in which will be placed the elevator which will raise the passengers to the station proper at the street level. The whole of the road to the Elephant and Castle is now practically finished, but without rails or rolling stock, and the two intermediate stations are in course of completion. This section of the line will therefore be opened for traffic in the first instance. A second section of the railway has also been begun, extending in a similar manner to Stockwell, which will eventually be the other terminus, and two or three intermediate stations will be constructed on the route. Considerable difficulties have been met with, but have all been successfully overcome; amongst others the subsidence of some houses on London Bridge has been laid to the scheme, and compensation and precautions required of the company, and even the recent fall of a piece of the cornice of the Monument has been foisted upon the tunnel, though it is proved this erection is not out of the perpendicular at all. The scheme is now some-

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what approaching completion, and the successful application of a conductor system of electric traction to this railway will make it one of the most interesting undertakings in this country.

Bath.—The report of the special Electric Lighting Committee at Bath, dated 16th inst., recommend that the wires be allowed to be placed overhead, chiefly on account of expense. The expense of providing and fixing the columns for the wires, which was to be undertaken by the corporation, will amount to £2,500; and as the raising of this sum is not provided for, the committee recommend that Mr. Massingham should provide for, maintain, and keep properly painted and in repair the 243 columns upon receiving £3 per annum extra for the 81 arc lamps, making the total payment per lamp per annum £21. 17s. 6d., instead of £18. 17s. 6d. The committee also recommend that the terms of the contract provide that Mr. Massingham have the power to assign the contract, with all its advantages and obligations, to a company with a subscribed capital of not less than £10,000, of which not less than £5,000 shall have been paid up, to be registered under the Joint Stock Companies Acts for the purposes of the undertaking; and that upon such assignment, and the assumption by the company of all the liabilities under the contract, the liability of Mr. Massingham and his sureties shall cease; and, further, that a provision be made in the contract embodying the terms which may have been sanctioned by the urban authority and agreed to by Mr. Massingham for private lighting within the proposed area. Although the terms adopted referred originally only to the public lighting, it appeared desirable to enquire as to the probable terms upon which occupiers within the area of the public lighting should be entitled to a supply of electricity for lighting their private residences or establishments, and as to the maximum price which should be payable therefore to the proposed company. The committee report that Mr. Massingham has consented to the following terms —viz.: All the occupiers of premises within the proposed area whose premises shall be within 30ft. of the electric mains which shall at any time during the term be laid by the contractor for the supply of private lighting, shall be supplied by the contractor with the electric light at a price not exceeding £2 per annum (payable quarterly in advance) for a lamp of 10 c.p., burning such hours each day from dusk to midnight as requisite according to the season of the year, subject to the consumer having had his premises properly wired and fitted with suitable lamps for the safe supply of the electric current upon the system or systems used by the contractor, the consumer entering into a yearly contract embodying the rules and regulations under which the current is supplied for private purposes. In the event of the contractor adopting to supply the current by meter, the meter shall be approved by the urban sanitary authority, and the charge to the general public shall not exceed 1s. (one shilling) per Board of Trade unit.

Telegraphing to Trains.—With reference to the recent sad accident in France, *Electricité* for last week laments the absence on railways of the means of countermanding by use of electricity the signals given to allow trains to pass, if, as happens in some cases, a signal has been wrongly given or a mistake is afterwards discovered, so that an otherwise unavoidable frightful accident may be averted. The case was put very strongly in a communication to the Kingston papers at the time of the Hampton Wick disaster: "One of the saddest points about the whole accident is the personal attitude of the signalman in such cases. For years and years he has gone on with his duty faithfully and conscientiously, making no mistake, till one day, under pressure of extra work, he makes a slip; he discovers it, may be, as in this case, immediately, and the position of the signalman may be better imagined than described. He has set the points wrong, sent the train on its deadly journey, and in a moment realises the whole horror of the situation. What is he to do? There is no means of communicating to the engine after it has passed the signal, or of stopping the oncoming train. He has made a mistake, and what is more, has no power, even if he finds it out before the accident, to prevent it happening. Very few of us are under such conditions in life, that by a single slip in our ordinary business we may launch numbers of our fellow-men into eternity, without the possibility of retracting our error if immediately found out. Imagine for a moment what the state of mind would be of an ordinary clerk or secretary, if every letter he wrote carried with it the certainty that a mistake in address might by some means hurl hundreds of men to destruction, and that there was an absolute veto on the part of the post office for any alteration of such mistake, and no possibility of telegraphing to the person the letter was addressed to. A signalman *is* in such a position, and may be tried for manslaughter for such a slip in his business practice. One of the most terrible and sensational railway accidents that ever happened occurred under similar conditions in these respects to those of the present accident, but with far more disastrous results. Who does not remember reading with horror the description of the accident at Monte Carlo? The train being despatched on the single line by some oversight of the station-master, while the train due shortly in the station was being despatched on the same line in the opposite direction. The station-master realised his error, but there were no signals to alter between the two trains. He rushed hither and thither, rung, for a futile resource, all the bells in the station, and yelled in his despair to make the engine-driver perceive his danger—but with no avail. And the whole number of officials and passengers on that station stood with awful dread watching the two distant white puffs of smoke getting nearer and nearer round the curve on the rocky shore, until they shaded their eyes with anguish when the two trains met and went over the precipice in blinding steam. May not the public ask, Is there no resource of science which will prevent such irremediable mistakes happening in the future? Accidents will happen; but when there is, as there sometimes is, considerable time after the discovery of the error, are there no means to stop the train at any part of its course?" The writer goes on to point out the security which might be obtained from this class of accidents by the adoption of some system of induction telegraphing to trains in motion as in use in America, or of telephoning by means of a Ruhmkorff coil in the guard's van as experimentally tried in France. It is obviously the duty of railway or other companies whose dividends are earned by taking charge of human life to be fully abreast in practice of the latest development of scientific research for the safe-guarding of life, and the remarks of *Electricité* on the recent accident in France add point to this by demanding that some better means ought to be provided for remedying possible errors than by the futile ringing of the station bell, or the insane knocking of the station-master's head against the wall in anguish over a fatal and irremediable mistake.

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NOTES ON CHOOSING AND INSTALLING ELECTRIC LIGHT PLANT.

BY L. A. DAVIES, A.S.T.E. AND E.

(Continued from page 322.)

Dynamo manufacturers design their machines on the basis of obtaining the maximum electrical and mechanical efficiency as cheaply as possible; in other words, they aim at giving their customers good quality, but as little quantity as possible, and their profit is a measure of their success. Now, a purchaser's desire tends in the opposite direction; he, too, wishes to get good quality, but good quantity also, in proportion to his expenditure. He has to pay a certain rate per unit of capability for his purchase, and the rate demanded is very much alike amongst the best manufacturers, varying with the market price of labour and material. It is his business to see that he does not pay more than the proper market rate at the time of purchase, or, in other words, that he gets due quantity for his money. It is in judging of the quality he is receiving, that lack of technical knowledge may cause him to go astray, and, on this point, a few hints may be of service.

The quality of a dynamo, like that of any other piece of machinery for the conversion of energy, depends on two factors—commercial efficiency and "running" efficiency. The commercial efficiency of such a machine is simply the ratio of energy absorbed to energy given out. This can be easily ascertained, before purchase, by a simple test, but it is generally taken on the guarantee of the maker. The "running" efficiency may be described as the ratio of the total life of the machine to the "periodic time"—to use a phrase much beloved of scientists—of breakdowns. This is a value which cannot be so definitely arrived at or the maker bound by, therefore the best plan for a purchaser is to go to a maker of established repute, and to examine his machines with some knowledge of where to look for weak points.

The "diseases" to which dynamos are liable, may be roughly summarised as follows—viz.:—

Wear on the commutator and brushes, failure of insulation between the different portions of the circuit or between them and the frame, and mechanical failures—such as wear on the bearings, and loosening of the attachment of the armature to the hub, &c.

The life of a commutator and set of brushes depends on the material they are respectively made of, the method of lubrication employed (if any), and, above all, on the amount of sparking between them. The material used for the commutator is almost invariably copper, and there is no doubt that this is the best substance for the purpose, on account of its high specific conductivity of electricity and heat, its toughness and power to withstand wear, its ease in working, and price. Brushes are also, as a rule, made of copper, but brass is not infrequently used. Considering that the resistance between two rubbing contacts represents (with a given current), just so much energy wasted, it might appear, at first sight, unwise to interpose a film of oil between them, but when the renewal of an expensive commutator and set of brushes is also reckoned, it will be found that greater economy is effected by wasting a little energy and going in for lubrication. Besides, the proportion of energy wasted is not great, and, in the case of high-tension machines working through a high resistance, where lubrication is most needed, it becomes insignificant. The lubricant employed should be thin, and not liable to get clogged and to accumulate under the points of the brushes. Mineral oils or vaseline are the most suitable for this purpose. Plumbago, or blacklead, as it is commonly called, is an admirable lubricant, and is also a conductor. Brushes are made in three forms—viz.: either of wire, plates, or plates subdivided into strips along a portion of their length. Wire brushes make excellent contact, owing to their numerous points, but they are apt to cut grooves in the commutator. Plates are free from this drawback, but are liable to cause sparking through only touching at a small number of points along their edge. Strip brushes are, perhaps, the best form, as combining the advantages of the other two. They should be made of thin metal in several layers. A brush has, however, been lately introduced which gives excellent results, and it is made up of a number of broad strips of copper or brass gauze, enclosed in a wrapper of the same material, the whole being soldered together at one end, and a quantity of powdered plumbago introduced between the layers. This brush makes excellent electrical connection with the commutator, reducing the sparking due to this cause to an infinitesimal amount, and the plumbago reduces the cutting action caused by friction in the same proportion, as becomes apparent from the glazed appearance quickly produced on the commutator surface. The commutator and brushes of a properly-wound and magnetically well-balanced dynamo will, with due care, last for a long period.

Sparking at the brushes is a very common fault with dynamos, and may be due, as explained above, to bad contact, or to more purely electrical causes. The point of each brush must, necessarily, be of sufficient thickness to bridge over the insulation between two consecutive sections. It should not be thicker than is sufficient for this purpose; but, if it does not effect this, it is obvious that the external circuit will be periodically broken. Now, when the point of a brush touches two sections at one time, the armature coil, the ends of which are connected to these two sections, is short-circuited, and the current passing through it is enormously increased, for the current in any circuit equals the E.M.F. divided by the resistance; and though the E.M.F. may be very small, still the resistance of an armature coil is also small, and so there may easily be a current of 100 amperes or more in the coil during the moment of short-circuiting, and you cannot break a circuit carrying such a current without a spark. This cannot be avoided completely, but the spark may be greatly reduced by setting the brushes so as to touch the point of lowest E.M.F. (or "point of commutation," as it is called), and the minimum E.M.F. may be kept down by so arranging the magnetic field that but few lines of force are cut by the coil when passing this point, and again, as the E.M.F. generated in a coil increases with the number of turns (other things being equal), by making the ratio of turns per coil to the total length of wire on the armature, as small as possible. The nature of the material employed as insulation between the commutator sections, affects, to a great extent, the amount of sparking. The substance usually adopted for this purpose is either asbestos or mica. Asbestos, as prepared in sheets, contains a certain amount of foreign matter which, under the combined influence of lubricant and heat, sometimes becomes charred, and more or less conducting, and it is also apt to retain, and allow to become imbedded in its surface, small particles of copper cut from the sections or brushes, and so, as an insulating material, it is decidedly untrustworthy. Mica, from its hard and more purely mineral nature, is free from these defects, and is admirably adapted for the purpose of insulating commutator sections, and it should always be specified for. Whilst on the subject of the commutator, reference may be made to the methods adopted for securing good connection between the commutator bars and the wires leading to the armature coils. The method commonly employed is either to solder the wires into holes or grooves cut in the bars, or else to clamp them in with screws. The best electrical connection is no doubt obtained by soldering, but considerable trouble is experienced if at any time it becomes desirable to undo the connection for testing or repairs. This difficulty is obviated by the use of screws, but they should be stout, and have a sufficient number of threads within the bar, or they may slack back and work out.

Every portion of the internal circuit of a dynamo must be carefully insulated from the frame, more especially in high-tension or series machines, and all conductors attached to the revolving portion of the machine must not approach any fixed portion too closely, nor be liable to do so through any possibility of becoming loose. In high-tension machines, again, there should never be any great difference of potential between two wires which touch or are liable to touch each other, unless the possibility of accidental abrasion and consequent short-circuiting has been foreseen, and special insulation provided between them. This is a point more affecting "cylinder" armatures than those of the disc type, as in the former all the wires of every coil

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meet and cross at the ends or "heads" of the bobbins, and it is one of the disadvantages of this system of winding. In the "Gramme" or disc armatures the various wires are only contiguous to others of very slightly higher or lower potential. The "Siemens" or cylinder mode of winding, moreover, renders it far more difficult and expensive to open out and repair injuries to the coils; in fact, in the event of the insulation of an inner coil getting damaged, it may be necessary to unwind the whole of the bobbin. The insulation between the commutator bars has been already considered; but here it may be added that, in addition to its other advantages, mica possesses a higher specific resistance than asbestos. The thickness of insulation between these bars should never be less than $\frac{1}{16}$th of an inch for shunt or low-tension dynamos, and not less than $\frac{1}{32}$nd for series or high-tension machines. The insulation resistance necessary between any two points increases with the E.M.F., and therefore one way of reducing the risk of short-circuiting is to increase the number of armature coils and commutator bars, and thus decrease the number of volts per bar. In actual practice the usual rate is about 7 to 10 volts per bar, and with this and mica insulation there is no risk of the current sparking through. The wires leading from the armature coils to the commutator are sometimes carried inside the spindle, made hollow for the purpose, with the object of keeping the bearing at the commutator end inside the latter, and so shortening the distance between the two bearings. This is an arrangement which frequently gives rise to trouble in the future, as the covering on the wires is liable to get damaged whilst they are being drawn through, and it is difficult to ascertain what state they are in. Testing with a small battery and a galvanometer is of little use, as a current at a high potential will easily spark through an insulation quite able to prevent any deflection being obtained through it from the battery.

The insulation between the armature core and coils is of importance, as if it gives way at one point the whole E.M.F. generated in all the coils will tend to force its way through the next weakest point, and so form a path for the current across the core. If, however, the wire is of sufficient cross-section to carry the current without being heated, and so prevent the insulation being thus injured, and all risk of abrasion is avoided, there is but small likelihood of break-down in the armature from this cause, and the same may be said of the magnet windings.

With regard to its general design, a dynamo is subject to the laws governing any other machine absorbing equal power at an equal speed. The frame must be strong and rigid, and the formation of the magnetic circuit lends itself readily to the attainment of these qualities. The bearings should be of ample surface, and a good rule for this is six to eight times the diameter of the shaft. They should also be not too far apart, having regard to the diameter of the shaft and the weight and peripheral speed of the armature. The bearings should be of phosphor bronze, or some anti-friction alloy. The magnetic field should be symmetrical and well balanced, and the armature truly centred in it, or an unequal attractive force will be exerted on the two sides of the armature core, causing undue wear on the bearings, and an unequal inductive action on the two halves of the armature circuit. When this occurs, a current will flow through the coils when the external circuit is broken, and will give rise to heating. Moreover, the two "points of commutation" will not be diametrically opposite and under the points of the brushes simultaneously, and sparking will be the consequence. The armature core and coils should be secured to the hub, and the hub to the shaft in a sound and mechanical way, and not by friction merely. A small amount of "end play" in the shaft is useful in keeping the wearing surfaces on the bearings and commutator smooth and free from grooves; but this cannot be obtained in disc machines, without sacrificing a good deal of power, on account of the extra air space it becomes necessary to allow between the sides of the armature and the pole shoe faces. The centre of motion should be low, and the machine should run perfectly true and without vibration. The bed-plate should be of sufficient depth to prevent any possibility of its being sprung when bolted down to a foundation posessing, perhaps, a surface not absolutely flush. Finally, a well-designed machine should be capable of being readily opened out for repairs, and the bearings should be capped and should allow of the caps being easily removed and the bearings adjusted. Sight-feed lubricators should be provided, so that the attendant may have no excuse for not keeping his bearings well lubricated.

(To be continued.)

LEAVES FROM THE DIARY OF A YOUNG ELECTRICIAN.

BY BROAD BENT.

(Concluded from page 303.)

November 3.—Now that all the lamps are in use nearly all through the day, the armatures get very hot. They are not ventilated at all. One gets much hotter than the other, so I have made a fan of vulcanised fibre which I shall fix on the end of the armature to-night, so as to drive a strong current of air round it.

November 6.—Although the fan I put on the armature a few nights ago creates a powerful draught, it does not seem to keep the armature any cooler. I find that the cause of its getter hotter than the other is, that it generates a higher E.M.F.; I can prevent that by putting a resistance in series with the field-magnet coils.

November 11.—There has been a thick fog for the last three days. The trains are worked by fog-signalmen, so, this being a junction, there is a regular cannonade going on outside. Several times the dynamos have almost pulled up, but from what cause I cannot make out yet. It is useless to put resin and tallow on the belts to prevent slipping, for that might result in burning up the armature, or, as happened a few minutes ago, in simply "pulling up" the engine. A message has just arrived from H. P.: "Come down here at once; we have had an explosion." What they mean by an explosion I don't know—unless one of the lamps has gone off bang, as they sometimes do.

November 12.—On going down to H. P. last night I was told that some wires up the steps "went off like a cannon," then "there was a blaze which lit up all the station for about a minute." On inspecting the place where the "explosion" had occurred, I found that a double-pole cut-out had arced across and become completely burnt out. This accounted for the dynamos "pulling up." The cause was probably this: owing to the fog, water from the condensed steam is running down the walls of the station in streams; the cut-outs, whose terminals are very close together, are entirely exposed to all this, so it is quite possible that a drop of impure water started the arc. On going round the other stations I found that two or three cut-outs had gone the same way

November 17.—A signalman kinder went for me a night or two ago, to use an Americanism. He wanted to know what "one candle-power" meant. I was half inclined to say that it did not mean anything in particular, as I have a very vague notion of what really constitutes the standard of light. However, I told him that it was the light emitted by a sperm candle, of which six weigh one pound, when burning 120 grains per hour. (I had seen that in a text-book the night before.) "What I want to know is this,' he said, "Is your standard the same as is used by gas companies?" I replied that it was. "How is it, then," said he, "that our three gas-burners, which are supposed to be 12 c.p. each, give more light than your three lamps of 16 c.p. each. "They don't give so much," I asserted; whereupon he lit the three gas-burners and turned out our incandescents—which, by the way, were new ones; and, although I would not admit it to him, I had to confess inwardly that the gas gave about 30 per cent. more light. Why this should be so I cannot understand, unless there is a different standard used by different makers.

November 30.—I had just sat down to tea last night, when the message came, "Electric-light man wanted at once—*cable on fire!*" There is something stirring about a message like that; and in almost less time than it takes to record it I was at S. M. What a disappointment! When I got there the fire was out—so also were three lights. The fire, I was told, occurred on one of the overhead cables, which at S. M.

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Station are very high; and, taking the mean of the varied accounts I received, I came to the conclusion that it was a case of "much ado about nothing" or "next to nothing." The cause of the fire was this: A wire carrying current to three lamps had, owing to the damp, become eaten through at the point where it was joined to the cable, causing a small arc to be set up. This, of course, set fire to the insulation and burnt about two or three inches of it—an absurdly small matter for people to be scared out of their wits about.

December 10.—S. M. Bridge is becoming a nuisance. Almost every day now a wire breaks there and puts out two or three lights. It is useless to solder the joints, for, no matter how carefully they may be covered, the damp gets at them somehow, and then electrolytic action soon causes the wire to become eaten away again. A twisted joint, unsoldered, lasts very much longer than a soldered one. The fact is, the bridge wants rewiring, and that on a much different style to the present. Whoever put up the wires before ought to be pensioned off, upon condition that he does no more wiring. (I suppose *he* calls it wiring.) However, to be charitable, perhaps the wires were run in summer when the bridge, though damp enough, is, comparatively speaking, dry. At present it is almost necessary to put up an umbrella to walk through it.

The insulation of the wires is so wet that I get a strong shock on touching it whilst standing on the floor of the bridge; so in order to repair a wire it is necessary to procure a dry plank to stand upon.

December 21.—For some time I have been at a loss to account for the destruction of some of our lamp-holders. I refer to those in use on the platforms. These holders, which are made of earthenware, were specially designed for this installation, as it was found that any holder in which metal was exposed was useless, the fumes and steam from the engines soon rotting the metal. A section of the holder now in use is shown in Fig. 7, from which it will be seen that no metal is directly exposed to the atmosphere.

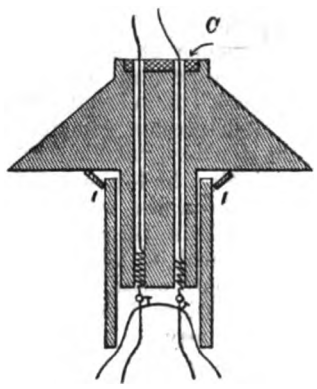

FIG. 7.—Earthenware Lampholder (sectional elevation).
C, cup containing bituminous substance; I, I, indiarubber rings.

The cup, C, is filled with an insulating substance, for which I know no other name than "black paraffin," although this is doubtless an incorrect term—"paraffin" being a *white* wax. However, from the look of it, I should think it is the dregs left in the bottom of petroleum stills, after the paraffin has been crystalised out. Perhaps I shall be correct in calling it a "bituminous substance."

Occasionally, we find that these holders are split and the terminal springs fused, as though they had been short-circuited. As no one is supposed to touch the lamps but ourselves, it has puzzled me very much to understand why this happens; but I have a theory now which I think explains the matter. About 50 per cent. of the lamps that we are sent for to put right are out owing to bad contact on the loops, caused by the "bituminous substance" melting, owing to the heat given off by the lamps, and running down the springs on to the terminals, T. Whilst the substance is in the liquid state, the weight of the lamp maintains the contact between the platinum "eyes" and the springs; but on being switched out the lamp cools and the substance solidifies, forming an insulating film between the points of contact. This prevents the lamp relighting when the switch is again turned on, so the cry at once goes forth "*Send for the electric light man.*"

Sometimes the least movement puts the lamp all right; at other times the hooks become red hot, and melt off, owing to the high resistance of the contact; and, again, the lamps are sometimes so firmly fixed that they are smashed in the attempt to move them. A few days ago, on attempting to put such a lamp to rights, a tiny arc was set up between a terminal of the lamp and that of the holder. The bitumen caught alight, then the terminals suddenly arc'd across, the lamp exploded (or else collapsed) and the holder was shattered, much to the alarm of a few interested onlookers. I thought at the time that I must have short-circuited the terminals by some means, so did not consider the matter further; but as the same thing has happened again, notwithstanding that I was particularly cautious, I must ascribe the fault to the holder and not to myself. My theory, which would also account for the *auto*-destruction of the holders is this:

Tar products are carbonised to a certain degree without much difficulty. At any rate, the sudden application of heat, such as that developed by the small arc, which occurs on moving the lamp, would be almost sure to effect the carbonisation of the small quantity which runs down upon the terminals, which would then be of sufficiently low resistance to start an arc across the terminals.

December 31.—S. M. Bridge is rewired, and so are several other almost equally bad places, so I hope we shall, in more senses than one, "turn over a new leaf" to-morrow—New Year's Day—and that next year's diary will record fewer break-downs than this year's.

SOME POINTS IN DISTRIBUTION BY TRANSFORMERS.

BY LUDWIG GUTMANN.

The distributions by transformers,* having in their primary circuits a pressure of 1,000 volts, have been attacked and considered dangerous; another system has been proposed of a tension of 300 volts.

It would not be wise to reject a system without sufficient proof of its danger, just as it would be very wrong to adopt another of which the safety has not been demonstrated.

As the comparative merits may be of interest, I shall, in this paper, endeavour to show by figures the respective reliability and safety of a 2,000 volt, a 1,000 volt, and 300 volt system. In case of a ground in a transformer, from the primary coil to the secondary direct, or indirect, through the core to the secondary, it is necessary that the insulation of the primary coil be damaged, and the bare wire be in close proximity to the core or the secondary coil. In either case it would be evident that more or fewer turns of the primary coil would be cut out of circuit, its length would be reduced and the resistance decreased. The greater the change in resistance of the primary coil, the greater will be the current that is forced through the primary fuse. We have, therefore, not to do directly with the current itself, but with the pressure employed and the resistance of the coils, or the rate at which the resistance can alter.

Let us now compare three systems worked with 2,000 volts, 1,000 volts, and 300 volts. For example I use a transformer of the same capacity in each case, say one that supplies 80 lamps at 50 volts and 1 ampere per lamp.

* I wish to call attention to the fact that medical coils, potential raising and reducing coils are called without distinction "converters." This name is too vague; it may mean as well an African missionary, as any mechanical or electrical apparatus which changes natural force or matter into a more convenient form. It is necessary that a special name be adopted for potential reducing or "safe system" coils, especially since the advocates of the continuous current have already diverted the attention of the people from the continuous current for capital punishment, which would, of course, give the public the impression that alternating currents and their distribution by means of transformers are more dangerous. How can we expect the public to know the difference between "safe system" coils and potential-raising coils if electricians do not make any distinction? The present state is injurious to transformer distribution, and leaves a powerful weapon in the hands of the supporters of the continuous current. A better name to adopt for coils reducing from *high to low* tension would be "transformer," which term is not so common, and appeared first with the parallel system and originated with Messrs. Zipernowski and Blathy. Two other simple names are "changer" and "reducer." For potential-raising coils the name of converter may be maintained.

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To simplify matters I will assume that there is no loss in the apparatus by transformation. The work which the secondary and also the primary have to perform is $50 \times 1 \times 80 = 4{,}000$ watts. This work is equal in all three cases, but as the pressure is different the currents in the primary coils are also different, and are found to be in the 2,000 volt, 1,000 volt and 300 volt system respectively:

$\frac{4{,}000}{2{,}000} = 2$ amperes; $\frac{4{,}000}{1{,}000} = 4$ amperes; $\frac{4{,}000}{300} = 13{\cdot}33$ amperes.

The virtual resistance in the primary coils at maximum load would be respectively:

$\frac{2{,}000}{2} = 1{,}000$ ohms; $\frac{1{,}000}{4} = 250$ ohms; $\frac{300}{13{\cdot}33} = 22{\cdot}5$ ohms.

The virtual resistance of the secondary coils in all three cases would be $\frac{50}{80} = {\cdot}625$ ohm. I assume that (for practical purposes) the change of resistance in the primary coil which can take place is from normal to that of the secondary circuit, and is respectively:—1,000 : ·625; 250 : ·625; and 22·5 : ·625; or the ratio of change would be as—

$\frac{1{,}000}{{\cdot}625} = 1{,}600 : 1$; $\frac{250}{{\cdot}625} = 400 : 1$; and $\frac{22{\cdot}5}{{\cdot}625} = 36 : 1$.

Now, let us suppose that in all three coils a ground takes place which cuts out, say, one-fifth ($\frac{1}{5}$) of each coil; the rate of change of current, or the strain on the fuse, will be respectively as 1,600 : 400 : 36; or, if we call that of the 300-volt system one (1), we have the ratios respectively—44·44 : 11·11 : 1.

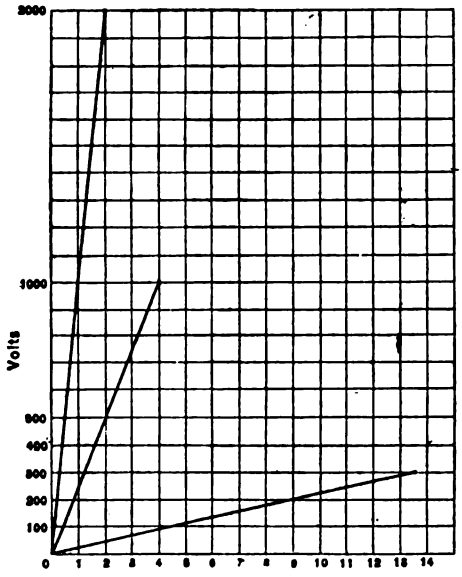

FIG. 1.—External Characteristics of Transformers.

These figures show that the same ground in the three converters has not the same effect, but that the current developed, and, therefore, also the strain on the primary fuse, is in the 2,000 volt system 44·44 times, in the 1,000 volt system 11·11 times as great as in the 300 volt system. Hence it follows that the safety of the secondary circuit with which the public has to come in contact is in the same proportion to these figures.

These ratios are more striking still if 100 volt lamps would be used with the 300 volt system, which would probably be done to compensate for heavier expense of primary conductors. In this case they will be found to be respectively as 177·77 : 44·44 : 1, or the 2,000 volt system is 177 times, and the 1,000 volt system 44 times as safe as the 300 volt system.

As a matter of fact, the resistances of the primary and secondary coils are nearer equal to one another the less these two circuits differ in pressure, and, if a slight ground occurs, it does not follow at all that the fuse will break in a 300 volt system. On the contrary, fuses are here no protection whatever, and we have in such a case the 300 volts in our secondary circuit without knowing it. To demonstrate this, let us continue our first-mentioned example. I will assume that a slight ground occurs in all three transformers, so that the current in the 300 volt coil will rise from 13·33 amperes to 16 amperes. This would not by any means cause the fuse to melt, but would allow the higher pressure to enter the secondary circuit. The ratio of this rise would be:

$13{\cdot}33 : 16 = 1 : x$, or $x = 1{\cdot}2$.

The rise of current in the three transformers would be respectively: $1{\cdot}2 \times 44{\cdot}44 \times 2$ amperes; $1{\cdot}2 \times 11{\cdot}11 \times 4$ amperes, $1{\cdot}2 \times 1 \times 13{\cdot}33$ amperes; equals 106·656 amperes, 53·328 amperes, 15·996 amperes. The currents, which have to pass a 2-ampere, a 4-ampere, and a 13-ampere fuse, have changed into 106, 55, and 16 amperes respectively. I would like to ask whether a 2 ampere fuse can carry 106 amperes; if a 4-ampere fuse can carry 54 amperes; and whether a 13 ampere fuse which has to carry this current constantly will melt with 16 amperes?

My former paper might have given the impression that the reliability depends on the fuses themselves, but these figures show that the fuse, however well or badly made, enters little into consideration, and that it is the nature of the transformer system that makes the fuses reliable or unreliable. This reliability does not alter in direct proportion to the tension employed, but as the square (second power) of the quotient of the pressures of the two transformer systems compared; $\frac{2{,}000}{1{,}000} = 2$, and $2^2 = 4$. The 2,000 volt system is four times as reliable as the 1,000 volt system. These figures agree also with the first ratio found, $\frac{2{,}000}{300} = 6{\cdot}66$, and $6{\cdot}66^2 = 44{\cdot}35$. The 2,000 volt system is 44 times as reliable or safe as the 300 volt system, $\frac{1{,}000}{300} = 3{\cdot}33$, and $3{\cdot}33^2 = 11{\cdot}099$. The 1,000 volt system is 11 times as safe as the 300 volt system.*

The reason for this fact is obvious. In transformers of the same type, and with equal number of alternations, the

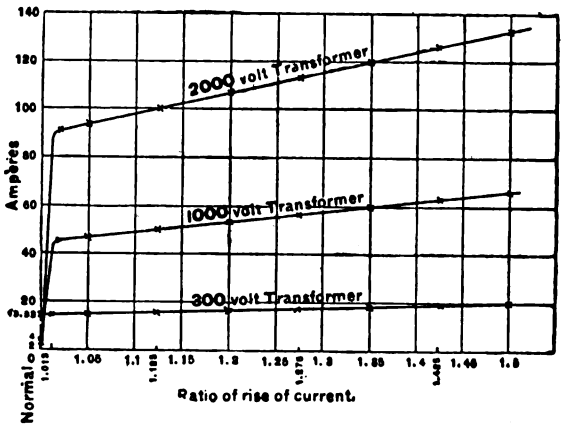

FIG. 2.—Ratio of Rise of Current.

counter pressure developed is proportional to the length of wire under induction; therefore, the primary wires in these three coils have a length respectively 6·66 : 3·33 : 1. Again, the work done in all three cases is equal, but is also equal to volts × amperes. It follows, therefore, that the currents stand in the reverse ratio to the pressure, and are respectively 1 : 2 : 6·66. If we now consider that by a ground not only a length of wire is cut out, but also that the ampere-turns are reduced, we at once see that the number of turns cut out for the same fault, or for equal reductions of ampere-turns, stands in the same ratio as the pressure, and, therefore, the effect must be as the square of the quotient of the pressures compared.

Fig. 1 of the accompanying diagrams shows the currents under normal conditions, and Fig. 2 represents the change of currents in the three transformers for equal faults. The rise of current in the 300 volt cost is taken as the basis.

I must admit that 300 volts in the primary circuit is several times less dangerous than 1,000 volts, but with due precautions and proper training of linemen there will be but little danger; while on the other hand, the public, as shown above, is exposed to 11, or 44 times as much danger of a shock from the primary current in the 300 volt system.—*Electrical World* (New York).

* The inaccuracy of the ratios is caused by the incomplete decimals.

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Letters await "Terminals" and "E. E."

NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

DEPTFORD.

Readers of the inimitable Mark Twain perhaps remember how that author and his companion muzzled or puzzled the guide who lovingly paraded the works of Michael Angelo, so much so that they were *sotto voce* dubbed lunatics. Perhaps the guide was a little too much imbued with the idea of the overwhelming genius of the great artist, and attributed to him what was of doubtful origin, as well as what was undoubtedly the creation of his brains. On Wednesday the designer of the great Deptford installation was laughingly dubbed the Michael Angelo of that installation, because from first to last, from foundation to top of highest turret, architecture, materials, foundations, and machines, all were specified or designed by one man, and the credit of the success of the really first central station in England will have to be given, without detracting one iota in favour of any other person, to Ferranti. As our readers well know, we have pretty consistently spoken of the perseverance and energy shown at the Grosvenor Gallery installation. Quietly and unostentatiously—too quietly from our point of view, for we could never obtain consent to say much about it—that installation has been carried to success. First undertaken as a private installation, it grew till it reached a plant designed for twenty thousand lamps, but that point has long been passed, and over thirty-three thousand lamps are lighted from this centre. Its capacity is reached. The promoters of the installation, however, confident in the possibilities of the electric light, confident in their business abilities, and supremely confident in their engineer, determined to erect what may really be termed a central station. It required some courage to jump from supplying tens to supplying hundreds of thousands of lamps, to put electric lighting upon the same footing as gas lighting, to supply an area as large as that supplied by the largest gas company. It required not only courage on the part of the engineer, but also a degree of confidence in himself that few men possess in the earlier days of industrial development. The question of distribution presented formidable difficulties, but it was met; experiments were made and a new design of main cables selected. A voltage unheard of in the previous history of the industry was determined upon, as were machines that even now frighten the cautious movers by infinitesimal steps. Nervous individuals talk of the danger to life and limb, but are met with a cool, calm, and confident assertion that you cannot get a shock accidentally, and it is doubtful if even a competent electrician could get one wilfully. Still, there is an old axiom that usually asserts itself when least expected, that the most probable is the unforeseen. So far the care taken in designing this installation seems to have left no loophole for dangerous shocks, but whether anything has been overlooked the future

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alone will prove. At any rate it may safely be predicted that the work will either be a gigantic success or a gigantic failure. If the former, as seems most probable, the future of electric lighting will be assured, for when the light is supplied at 7½d. or less per unit there can be no question of its power to compete successfully with the illuminant already in the field. It is not our intention here to describe the arrangements at Deptford in lengthy detail—that is better done in another column—but we may say the intention is to start with a battery of Babcock-Wilcox boilers of twenty thousand h.p., supplying steam to vertical Corliss engines, which will drive two large and two smaller dynamos. Taking eight lamps of 20 c.p. nominal to an indicated h.p. or double this number of lamps of 10 c.p. nominal, this gives a starting capacity of 160,000 of the former lamps or 320,000 of the latter. The plan of the station has been so arranged that it may be enlarged up to some six times this capacity. These few figures will show that there has been no hesitancy either on the part of the capitalists or of the engineer. A leap has been taken far and away in advance of all that has been done before, or that has been contemplated. Good work has been and is being done at the smaller stations designed for ten or twenty thousand lights, but these present comparatively few of the difficulties that are met with in an installation designed, when working at its full capacity, to supply one quarter of the light of London. The requirements of the metropolis may be taken to be equivalent to between six and seven million lamps of 10 c.p., so that the competition of electricity with gas in the metropolis, when we take into consideration the minor installations fast coming into operation, as well as this larger one at Deptford, will soon be a reality. Most of the installations in hand will be in running order by January next, that is, they will be then in a position to supply customers with current. We imagine that when a large installation like the one referred to gets into full operation the curve of load diagram will be considerably flattened, because supplying a large district means supplying different classes of consumers, whose requirements do not all come on at the same time. The city offices, for example, close about the time that residential districts require light; a large proportion of the shops, again, are closed when the theatres and restaurants are in full swing. An installation over a general district should have a flatter curve than one supplying a special district. The work, then, of the Deptford installation will be closely watched for the solution of many difficulties. As we say, it is contemplated by many as a leap in the dark, and prophets of disaster are not wanting. Distribution to sub-stations by means of very high potential currents, and from sub-stations to consumers' transformers at a lower potential, necessitating a double transformation, will be on trial. The Grosvenor Gallery installation has proved the feasibility of distributing current of 2,000 volts potential. In the Deptford case the first transformation downwards will be from 10,000 volts to 2,000 volts, after which the experience of the Grosvenor Gallery comes into play. We have sufficient confidence to predict that the experience of the Grosvenor Gallery has not been lost, and that the details of the present scheme have received the closest attention to warrant belief in a satisfactory result. Undoubtedly difficulties will be met with as the work progresses, but these will be overcome as they arise, because, from all appearance, they cannot be fundamental. We hope, then, that the beginning of the new year will see the successful inauguration of this gigantic enterprise.

THE LONDON CHAMBER OF COMMERCE.

On Monday last a goodly company mustered at the rooms of the London Chamber of Commerce in Eastcheap, in order to hear something definite as to the formation of the electrical section of the chamber, and to elect a working committee. Soon after the time appointed for the opening of the meeting,

Mr. R. E. CROMPTON was voted in the chair,

and his first duty consisted in suggesting that the members forming the organising committee should take their seats at the table in support of the chairman.

The minutes appointing the organising committee were then read and confirmed.

Messrs. Robinson and Trotter were appointed scrutineers of the ballot, and retired with balloting papers to perform their scrutineering functions. Meanwhile the general meeting would have formed a set of conversational centres during the counting of votes had not the chairman come to the rescue and moved that the report of the organising body be taken as read and adopted, and suggested that now was a favourable moment for criticising the report of that committee. The members generally evidently thought the report satisfactory, or if in their inner consciences they thought otherwise, did not deem the moment an opportune one for criticism.

General WEBBER, however, was called upon to fill the gap and say something, so—like the good general he is—he took advantage of his opportunity, told the members present that the organising committee ought to be congratulated upon so satisfactory a completion of its labours; then, with that suaveness so characteristic of him, commenced to combat the opinions we expressed last week that the working committee should be chosen by each subsection selecting its own quota. General Webber thought that as the number of members was comparatively few, every member must know every other.

Mr. HAMMOND was next called upon, and, though usually a fluent speaker, and as able as anybody to talk about nothing against time, he thought it would be more to the purpose if the chairman, or someone who had definite ideas upon the subject, would enlighten the meeting as to what this electrical section was going to do. Pathetically he spoke of having gone to San Francisco and back since the formation of the organising committee, and hence was ignorant as to how far or how fast matters had progressed.

The CHAIRMAN rose smiling, and accepted the challenge, though having made no notes or prepared a set scheme; he guarded himself by only giving ideas that floated across his mind on the spur of the moment. Electric light engineers had a good deal of work with local authorities, and a great many questions would have to be settled. Combined action would be preferable to coming to a decision upon these questions, and the conclusion of a united body

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would carry much more weight and be very differently received to the opinions of individual firms; similarly in their business with the Board of Trade. How to deal with these bodies was of vital importance. Such questions as those relating to ransom, rating, underground and overhead wires would have to be settled. For his own part he thought that some questions relating to master and man might require concerted actions, such as what hours in this trade were to constitute time and what overtime. He felt sure also that sooner or later questions relating to prices would have to be discussed, and some uniformity arrived at in regard to similar classes of manufactured goods. Further, consumers had their views in regard to various matters, and here suppliers and consumers might meet upon common ground and agree so far as in the nature of things they could agree their differences. He then referred to the arduous work of the organising committee in determining the number of sub-sectional representations. Several sub-sections were under represented, but the future would remedy the evil, for as the members increased the working committee would be increased to its maximum limit of forty-eight.

Colonel JACKSON asked whether it would not be possible to have every class of every sub-section represented upon the committee. Naturally, each sub-section includes a number of claims—thus telephony has managers, linemen, inspectors, &c., each of whom is fully conversant with his own particular work, but not with that of his colleagues; and by the selection adopted it might happen that men possessing valuable knowledge would not be on the committee.

[It will be seen that Colonel Jackson supported our view that the outsiders do not know the merits of sub-sectional members so well as the members of the sub-sections themselves. His point was not seen, or if seen was not answered.]

Mr. RAWSON explained that if an insufficiency of members in a sub-section was elected, the deficiency would be made good by the committee nominating other names from the sub-section. He also stated that in many cases the sub-sectional committees would themselves deal with questions relating only to their sub-sectional matters, then, proceeding to his views of what the section as a whole could take into consideration, he mentioned the fixing of rules in cases of overlapping supply companies—that is, the charges and arrangements to be made on ground common to the overlapping companies. Arbitration matters would form part of the work of the section. Some legal questions also which would affect the trade generally, such as test actions against one firm, the expenses of which under united actions could be borne by the trade generally. In Parliamentary matters unity meant strength. In patent cases some good might be done, though this was, again, more a question of arbitration. Mr. Rawson then suggested that it might be advisable if the working committee were authorised, if they deemed it necessary, to elect their chairman and vice-chairman from among the general body of members outside of the thirty-three elected.

Mr. WALLACE made this suggestion a substantial motion, and

Mr. MARTIN seconded it. Carried unanimously.

Mr. GARCKE then continued the discussion upon the work of the section, stating his entire accord with most of what had been said, but venturing to differ with Mr. Crompton as regarded the matter of prices. He felt that the work of the section was more in the way of ascertaining the general views held by the trade rather than in legislation for the trade. He believed their work would be more deliberative than administrative. It would prove of essential service in many circumstances to have a representative body speaking in the name of the whole industry; and especially would this be the case in questions arising in the Legislature, in contact with local bodies, with the fire offices. Great benefits also might come from decisions resulting in concerted action with regard to badly-drawn specifications.

Mr. CROMPTON adhered to his opinion that whatever might now be thought to the contrary, such questions as prices and wages disputes would inevitably have to be considered.

General WEBBER suggested that as time was passing the meeting should adjourn, and have the result of the ballot sent by post; and after ascertaining that the scrutineers had only got about half-way through their task, this was agreed to.

Mr. REEVES moved, and Mr. MARTIN seconded, that the report of the organising committee be adopted, and it was adopted.

Mr. WALLACE moved a vote of thanks to the chairman, which was carried unanimously.

RESULT OF THE VOTING.

(The names are placed in order of number of votes given, and those bracketed together indicate a tie.)

Telegraph Companies (5).

Sir James Anderson.
Sir John Pender.
Mr. J. H. Tritton.
The Marquis of Tweeddale.
{ Anglo-American Telegraph Company.
{ Mr. C. W. Earle.
{ Mr. R. K. Gray.

Electrical Manufacturers and Contractors (13).

Mr. R. E. Crompton.
Mr. Alex. Siemens.
Mr. Moritz Immisch.
Mr. E. Garcke.
Messrs. Woodhouse and Rawson.
Messrs. Johnson and Phillips.
Messrs. Laing, Wharton, and Down.
Messrs. Callender and Sons.
Messrs. Drake and Gorham.
Sir Daniel Cooper.
Messrs. W. T. Goolden and Co.
Edison and Swan United Electric Company.
{ Verity Bros.
{ Mr. J. J. Courtenay.

Telephone Companies (3).

Mr. J. Brand.
Colonel R. R. Jackson.
Oriental Telephone Company.

Electricity Supply Companies (6).

Major-General Webber.
The Earl of Crawford.
Mr. J. E. H. Gordon.
Mr. Roger Wallace.
Mr. Mark Parker.
Mr. R. S. Erskine.

Consulting Electrical Engineers (4).

Mr. W. H. Preece.
Mr. Gisbert Kapp.
Messrs. H. Alabaster, Gatehouse and Co.
Mr. W. H. Snell.

General (2).

Sir David Salomons.
Mr. Quinton Hogg.

THE DEPTFORD CENTRAL STATION.

The complaint has been in our ears long enough of the backwardness of England, and especially the backwardness of London, in the matter of electric lighting; but that complaint will be very shortly a memory of the past, and London will be able to boast not only the largest installation in the world, but one absolutely unique in the vastness and the comprehension of its details, one which will amply bear out the claim of England to be the first and best in matters of practical science. The cry has been, while others are plentifully using the light, Why should London wait? but if, by waiting, London can achieve, by the help of its engineers and capitalists, supremacy in the application of electric lighting, as it has already achieved supremacy in other and diverse departments, London will not have waited in vain.

There is an air almost of necromancy, an Aladdin's lamp kind of effect, upon the public and untechnical mind on

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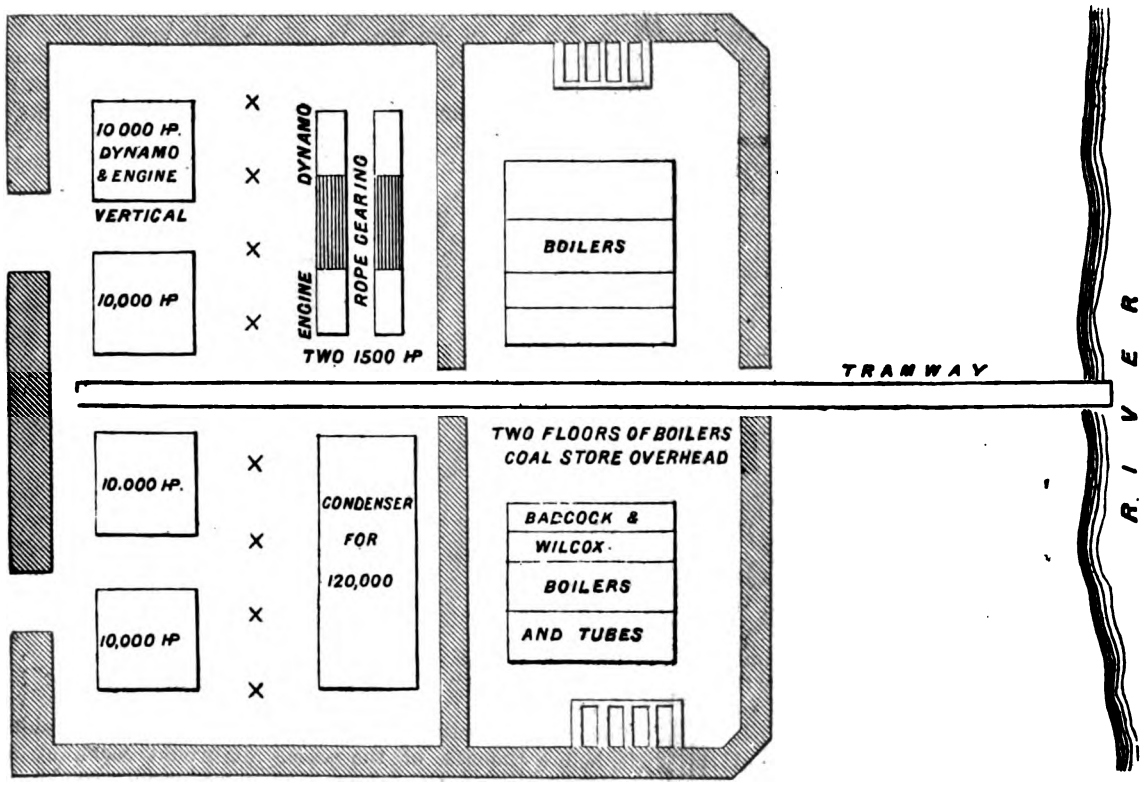
learning the details of the scheme we are about to describe, which is to cover London—from the Tower to Kensington, and from Charing Cross to Hampstead—with a vast network of wires to supply electric light; the mains of which, however, are only copper tubes, 2½in. in diameter, yet each carrying enough to supply half a million lamps or so, along by the side of the railway lines, from a monster station some miles down the river—a system, moreover, which has been rendered, to all intents and purposes, in spite of its enormous electrical pressure, practically and absolutely free from danger.

It has been known for some time that the Grosvenor Gallery Company, which has lately been incorporated as the London Electric Supply Corporation, Limited, and who have at the present moment some 33,000 lamps running from their Grosvenor Gallery centre, have had a scheme on hand and work actively progressing for a supply on a greatly extended scale from a large central station at Deptford. On Wednesday, a number of the representatives of the technical papers had an opportunity of inspecting the work as it at present appears, and of ascertaining particulars of what will be one of the most gigantic lighting schemes of modern times. The Grosvenor Gallery scheme



Sketch Plan of the Deptford Central Station.

was due originally to the enterprise of Sir Coutts Lindsay, developed afterwards with the active assistance of Lord Crawford and Mr. John Pyke, and working in conjunction with Mr. Ferranti, engineer to the corporation, to whose knowledge of electrical engineering and talent for designing the new and immense machinery necessary for the work the possibility of carrying out the scheme in its present scope is almost altogether due.

The site of the station is near the premises of the General Steam Navigation Company at Deptford, and is a fine riverside site of about four acres in extent, almost the whole of which—with the exception of a wharf, retained for unloading the great masses of machinery and the supply of fuel—will eventually be covered with engines and boilers of great size and most massive construction. The buildings are arranged so as to be easily capable of extension, the boilers being added in the direction of the river and the engines towards the road. A tramway runs from the river side direct into the building for unloading the machinery and material. The company will own their own coal vessels, which will bring the coal direct to the wharf, and from which it will be raised by hydraulic-lifts to an overhead tramway running to the coal store, which will be on the top of the building. The buildings now in course of construction consist of a boiler-house and two engine-houses, occupying together a space of 210ft. by 195ft., and having a height from basement to roof of about 100ft. In the corner of this vast building is hidden away an electric lighting plant equal to many provincial central arc stations, used for supplying light to the workmen on the buildings at night. This consists of a Thomson-Houston plant giving thirty-eight arc lights and a Ferranti machine for forty incandescents. The general disposition of the building is indicated in the diagram of the station, which we reproduce from a pencil sketch by Mr. Ferranti. The other diagrams are also reproduced from his sketches. These will enable our readers to understand the description, although illustrations of the machinery are not yet prepared.

The two engine-houses now in course of construction are each 195ft. in length, 66ft. in breadth, and 85ft. high. The engine-houses are separated from the boiler-house by a massive wall of masonry, and a row of iron pillars of immense strength separate the two engine-houses. These supports are required for support of the roof and the overhead travelling cranes, but beyond this there is nothing to impede the view of the whole of the engines, and the engineer in charge will be able to obtain a comprehensive view of the whole from a gallery specially provided for him.

The first portion of the plant to be put into position and working order in the first engine-house will be two "small" (!) engines of 1,500 h.p. each, connected with rope gearing—forty cotton ropes of 5in. diameter—with two Ferranti dynamos for 25,000 lights each. These "small" dynamos are by far the largest electrical generators that have been yet constructed; the largest, or, to speak more accurately, those with the largest output, now in actual work being the dynamos of this same company at the Grosvenor Gallery, which are for 15,000 lights each. The engines are Corliss engines, constructed by Messrs. Hick, Hargreaves and Co., and will be used for the minimum supply at first. A steam travelling crane, 60ft. overhead, will traverse the engine-rooms from end to end, capable of lifting twenty-five tons. Besides the machinery mentioned, the first engine-house will contain the exciting dynamos, hydraulic gear, and the condensing apparatus.

In addition to this, which itself would be one of the largest electric lighting plants in existence, the second engine-house contains the "large" dynamos, each of which will be driven, when at full power, by a pair of vertical

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Corliss engines, coupled direct to the dynamo, of 10,000 h.p. There will be two dynamos of this size first installed, but at present they will be driven by only one out of their pair of engines, being 5,000 h.p. each, and giving with this power 100,000 lights each. Eventually, as the demand increases, the second engine to each dynamo will be added, each dynamo being capable of supplying a total of 200,000 lights. As the demand still further increases, this plant will be used for the day work, and two other 10,000-h.p. engines and dynamos will be put down in the positions indicated. For the manipulation of the heavy pieces of machinery for these machines an overhead travelling-crane will be erected similar to that in the first engine-house, but capable of lifting 50 tons. After the capacity of the present buildings is exhausted, fresh buildings will be constructed, and a total of two million lights is capable of being supplied from the present area of the ground. As the total number of lights at present in use in London is somewhere about five millions, the London Electric Supply Corporation evidently contemplate supplying half this total number, eventually, from their Deptford station.

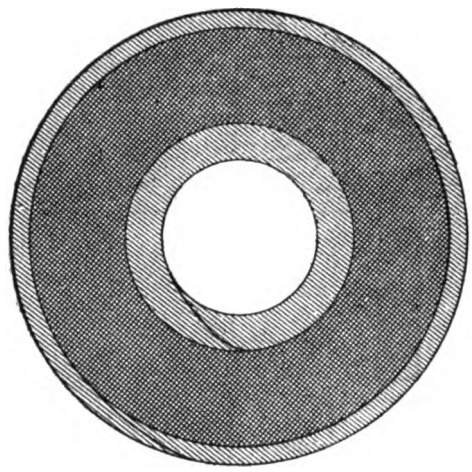
The boiler-house is entirely distinct from the engine-house, and the boilers are to be arranged in two floors, one above the other, the upper floors being supported on iron pillars of immense strength, 30ft. high, with the coal-store above them, capable of storing 4,000 tons of coal. The coal will be unloaded straight from the wharf, and hoisted to the top floor of the boiler-house, from which it can be distributed by means of vertical shoots, passing through the centre of the floors of the upper boilers to the lower ones. The soot from the flues will be periodically cleared out by steam travelling scrapers running on rails inside the flues It may be said that throughout the building every known labour-saving device is made use of, and no expense is being spared to employ all the best-known means of combining efficiency with economy in the carrying out of this great enterprise. The boiler-house is a great building, 195ft. long by 70ft. broad, nearly 100ft. high, and is constructed to contain boilers of 65,000 h.p. Those at present being erected are 24 in number, equal to a total of 20,000 h.p., Babcock and Wilcox boilers, in eight sets, each complete with its own economisers and flue. Condensing apparatus will be put down in the engine-house, in the position indicated, for the whole number of engines and boilers capable of being placed in the present building, equal to a total of 120,000 h.p., but the remainder of the boilers will be added as required. The chimneys for this immense battery of boilers are of the largest, if not actually the largest, shafts in the world, measuring 18ft. by 24ft., and subdivided into four flues in each. Each set of six boilers has its own flue, and the economisers are placed at the base of the shaft, before the chimney proper, where the heat from the waste gases may heat the feed water. The chimneys will be 130ft. high. The whole of the area of the buildings is covered, first, with a ground of concrete 4ft. thick, and the walls of the building in many places are 6ft. thick. With the exception of the roof-boarding, the buildings consist solely of iron, stone, concrete, and brick, and for massive construction and strength it is doubtful if they are exceeded by any buildings in the country. The whole building promises to be one of the most remarkable industrial establishments of the metropolis. Some 8,000 cubic yards of concrete and about 33 million bricks have already been used on the works, besides several thousand tons of iron.

The unique features about this colossal enterprise are many, but perhaps the most remarkable is that the whole of the scheme has been invented, designed, and laid out by one single man, the corporation's engineer, Sebastien Ziani de Ferranti, who, as is well known, in spite of his name, is an Englishman, born and trained in this country. He has with his own hand, and without the assistance even of a draughtsman, designed and made drawings for the whole of the works, building, and machinery, even, it is said, to the mouldings; the only thing he has not done evidently has been to lay the bricks, and that he has personally superintended. He has given out all the contracts to the extent of some hundred thousands of pounds, and engaged the workmen, and all this besides making the necessary and important experiments and tests which will enable a plant giving 10,000 volts to be run in a manner perfectly safe to human life, and all the while carrying on large works of his own for the manufacture of his transformers.

Not a less interesting fact to electricians generally is the statement that throughout the installation, instruments and switchboards will be practically absent. The only instrument in use will be a single Cardew voltmeter, connected to a test transformer circuit used to light the offices of the works. Possibly an ammeter will be inserted occasionally for their information in the main circuit to test the actual current, but this is not necessary for the working of the installation, the regulation of which is entirely effected by the governors of the engines.

Another important feature with regard to the safety of men working upon the place, is that the whole of the dynamos will be enclosed and magnetically locked by the exciting current, so that it will be impossible, even if it were attempted, to get a shock from the dynamos themselves. The metal lid of the box surrounding the brushes is so arranged as to form part of the exciting circuit; no one can open the box while the exciting current is on, and the exciting current cannot pass while the box is open. To excite the dynamo, it is necessary to close the box, and in so doing it is magnetically locked, so that the brushes cannot be touched while the dynamo is working.

One of the most important and interesting details of such a scheme of high-tension distribution is, of course, the conducting cable; and here, as in other details, no precedent was obtainable for such high voltages, and Mr.



Section of the Deptford Cable.

Ferranti had to invent his own cable to suit the requirements of the case. It would seem, at first thought, that the most important point would be to insulate most thoroughly the whole cable from the possibility of touching with the hand. But this is by no means the way in which the problem has been solved; on the contrary, one of the conductors is bare copper, open to the air, and which may be freely handled without danger. This is accomplished by the fact that throughout the whole system one end of the primary is connected to earth, and the difference of potential between it and any human body is therefore nil. By this simple means, and by enclosing the high pressure end of the main inside this outer copper conductor, separated from it by the most perfect insulating compound obtainable, it is possible to distribute the electricity at this enormous pressure, and yet render it not necessary to take any more precautions in running the main than an ordinary gas-pipe. The danger in high-pressure wires consists in the effect of a number of small leakages, but with these concentric cables there is nothing between a dead breakdown and perfect safety.

The section of the conducting main is shown in the accompanying illustration. It consists of two concentric copper tubes of the same total sectional area, the inner one of pure copper $\frac{3}{16}$in. in thickness, and the outer one $\frac{3}{32}$ of an inch. Between this is an insulating compound, the nature of which was not explained, but which consists of an ordinary insulating substance, costing a few pence per pound, but specially treated under great pressure.

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This is placed upon the inner tube, and over this the outer tube is slipped, and is then drawn down under pressure until the whole is one solid mass. This cable will be made in 20ft. lengths, and by a special joint can be connected together with as little labour as a gas-pipe. The difficulty in such high-pressure joints is that due to surface leakage, and to obviate this it is necessary to have a very long surface insulation joint, and by a special arrangement of joint, which will be described in detail later on, this is very simply performed by a single operation, giving about 2ft. of surface insulation, and without baring more than 4in. of the cable. The total diameter of this cable is $2\frac{5}{16}$in., and the current to be sent is at the rate of 330 amperes per square inch, which is sufficient with one cable to supply 100,000 lamps of 10 c.p. The voltage loss on all mains is very small, less than 3 per cent. over all, and the retardation is stated to be quite negligible—less than $\frac{1}{2}$ per cent.

In order to get the supply of electricity from the central station to the points of distribution in London, the very brilliant idea has been carried out of utilising the lines of the various railroad companies running into London from the south, so that the high-pressure mains will be able to radiate from every railway terminus from Cannon-street to Kensington. After long experiments, undertaken to convince the companies of the absolute safety of the mains, contracts have been entered into with the Brighton, the South-Eastern, and the Chatham and Dover railways to bring the high-pressure mains along

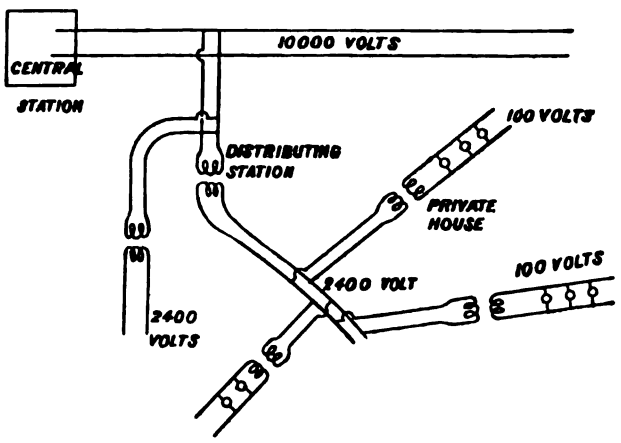

Diagram of Circuits.

the lines into their stations, and also to run the mains underground along the District Railway. Two main cables will be brought to each of the following—viz., Cannon-street, Ludgate-hill, and Charing Cross, and distributing stations, consisting of buildings with cellars and roof, abutting on to the railways will be prepared for the reception of the cable ends and for the secondary transformers. The principle of distribution is shown in the diagram, being, in reality, three sets of superposed circuits, connected in parallel. The first circuit at 10,000 volts will reach to each terminus, and will be connected also to other distributing stations situated at the Monument, the Grosvenor Gallery (replacing the present machinery), to Kensington, and will eventually extend to Hampstead. At these distributing points the current will be transformed (or "expanded," as the corporation call it, using a well-understood analogy) down to 2,400 volts, which is the pressure now used at the Grosvenor Gallery. The transformers used will be of 125 h.p., weighing nearly one ton, each capable of supplying 2,500 10 c.p. lamps, and from these stations the current will be distributed overhead, as at present is the case from the Grosvenor Gallery, by 19-15 cables, carrying current for 5,000 10 c.p. lamps. These will be led to the private houses, each of which will have its own transformer, "expanding" the current till the pressure is only 100 volts, and can be used in the ordinary incandescent lamps. The price will be the same as now charged in Bond-street and neighbourhood—namely, 7½d. per unit, equal to gas at about 4s. 2d. per 1,000—and it is of course possible, as the machinery gets into operation, that the price, already very reasonable, may be still further reduced.

Tests have been made from time to time with the full pressure of 10,000 volts, and as the machinery is not yet ready for its direct production, the method adopted was one exactly analogous to the Ruhmkorff coil arrangement, only on a much greater scale. One of the 10,000 volt transformers was worked backwards, a large and lower pressure current being sent through, obtaining a current of very small capacity, but of the required pressure of 10,000 volts. That this pressure actually was obtained was not indicated by instruments, but by the simple arrangement of stringing four rows of twenty-five lamps each of 100 volts in one series. A photograph of this arrangement, with all the lamps alight, was shown by Mr. Ferranti. This is probably the first time that anything like this amount (0·7 ampere, 10 h.p.) has been produced at this pressure. The actual spark through air of this voltage is $\frac{5}{8}$ of an inch, and an experiment was made and photographs taken, showing this $\frac{5}{8}$in. spark in space. Experiment with ebonite insulating plates, however, show that even when scraped to $\frac{1}{32}$ of an inch, 10,000 volts will not pierce the insulation. The cable insulation, as will be used in practice, was first settled at $\frac{3}{8}$, but has since been increased to ½in., under which circumstances it is impossible for sparking to occur. To test this practically in manufacture a Wimshurst machine has been made to give a 6in. spark, and all cables will be tested to stand this—a pressure of some hundreds of thousands of volts. In the transmission of such high electrical pressures, Sir William Thomson has shown that the interior of a solid copper rod is practically useless, and the weight of the inside copper is thrown away. The cables are therefore both made cylindrical, the inside one of sufficient diameter to ensure a practical result.

The following are a few of the details of the Ferranti dynamos. The small machines will be 12ft. 6in. high, 15ft. over all; the large machines will be 45ft. high over all, and will weigh 500 tons each. The number of alternations of current will be 4,000 complete cycles per minute (67 per second) in all machines. In the small machine there will be 48 poles, and the speed 168 revolutions per minute. The large machines are to be coupled direct, and the speed is sixty revolutions per minute only, the peripheral speed being obtained by the largeness of their diameter. The coils of the dynamos are built up in the same manner as an ordinary dynamo, each coil generating 125 volts. These are very strongly mounted mechanically, and most carefully insulated, the principle being to bury the conductors in the insulation. The insulation used is sulphur, specially treated, and is so hard that in one case where some metal was found to be mixed with the sulphur it took two days to chip out one coil. The sulphur eats partially into the cast iron and bronze, and makes a thorough joint. Besides this, the surface insulation is carefully arranged to be of porcelain throughout. The electrical efficiency of the armature is very great, two volts being obtained for every foot of copper. There is not more than two per cent. loss in the dynamos. In constructing the armature coils for this enormous potential, Mr. Ferranti gives the following as leading principles: (1) the insulation itself must not be penetrated, (2) the surface insulation must be effective against creeping, and (3) the draught must take the dust clear from the insulation.

The supply of electricity will be principally by meter, and Ferranti's meter, with revolving mercury, now used on the Grosvenor circuit, will be employed on these circuits to register the consumption in the private houses. The meter is enclosed in a round cast-iron box of very moderate dimensions, and the current used is indicated on dials, as in a gas-meter. The trains of wheels for these meters have been on order for some time with the Waterbury Watch Company, and arrangements are made by which, at eight hours a day for 300 days in the year, 15,000 trains of wheels can be turned out, and the plant could be doubled at a moderate expenditure if found necessary.

In order to cope with the demand for transformers, Mr. Ferranti's works in Charterhouse-square, now employing 150 men, will be shortly extended to employ some 500 men in turning out the high and low pressure transformers and other work connected the station.

In addition to all these exhaustive details, undertaken

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for the complete supply, on an extended scale, of electric light to London, the corporation have made arrangements by which they control the alternate current motors in England. The Tesla motor, as is now well known, is operated by two slightly different alternate currents; but there are patents by, we are told, a Swiss inventor, which practically antedates the whole of the alternate current motor patents, and the patents of the same inventor have also anticipated, it is said, the principle of the Schallenberger meter. Details of the motor in question are not yet forthcoming, but it may be taken that it is a compound alternating current motor capable of being worked from a single circuit, and therefore practical for use on the Deptford circuit. If this is the case, and motors can be supplied for ordinary use from, say, 1 to 20 h.p. to be run on a single wire on an alternating circuit, the London Electric Supply Corporation will have practically doubled its field of usefulness. We have said enough, however, to interest electrical engineers all the world over, and those who work in conjunction with them, and to convince the public and the gas companies that the future of electric lighting in England is in a slightly different position to that which they have too often been accustomed to think it. This revelation will also, we think, cause our American cousins to reconsider the verdict of the continued backwardness of England in the matter of central stations for electric lighting.

OVERHEAD AND UNDERGROUND WIRES IN NEW YORK.*

BY DR. SCHUYLER S. WHEELER.

(*Continued from page 330.*)

"In Philadelphia a comprehensive 'drawing-in' system of iron was seen, containing electric light and telephone and telegraph wires.

"In Boston, some two miles of such 'drawing-in' iron systems are in operation.

"In London, 9,000 miles of wire are underground, bunched into cables, and drawn into 3in. iron pipes.

"Solid systems, or those where wires are permanently embedded in insulating material, and incapable of being reached except by tearing up the streets and the insulation, have been found to work with more or less success. The commissioners saw several miles of this conduit in successful operation in Chicago by the telephone company there, where wires were buried in an asphalte or coal-tar cement, laid in a wooden trough.

"Several miles of similar conduit are in use in Washington for electric lighting, and there are other instances of the successful operation of this description of conduit.

"In this city of New York there are several systems in use underground, each more or less satisfactory to those employing it.

"A prominent example is the Brooks' system, used by the Metropolitan Telephone and Telegraph Company. It consists of an iron tube in which cotton-wrapped wires are drawn, and the tube filled with oil, the oil acting as an insulating medium. It is kept at a desired pressure—the tubes constantly full by means of a stand-pipe. They use a 2½in. iron pipe, and the system is cheap, costing less than 11dols. per mile of wire, because into such a pipe they can draw 300 telephone wires. Wires for telephonic purposes, and those used in the American district and other call boxes, are of a very light intensity, and do not need as heavy insulation as do all other kinds. This system is claimed to give perfect satisfaction for telephone conductors.

"The Western Union Telegraph Company has many wires already down in this city, laid in 3in. iron pipes, into which they draw cables manufactured from okonite or kerite insulation. These pipes are lead jointed, are laid in Broadway, and have man-holes occasionally for taking out the wire.

"To sum up as to the form of subway, and the manner in which the wires are to be placed in it:

"We are convinced that from the standpoint of an electrician simply, it may be said that almost any plan or system can be *made* to work from a single lead covered wire laid directly in the earth to a great tunnel upon whose walls the insulated conductors can be hung. Within certain broad limits any system is electrically practicable; retardation and induction can be overcome. It is only when we face in this city the mechanical engineering and chemical questions of interference with water pipes, gas pipes and sewer pipes, of obstructions from vaults, or danger from steam pipes, of the action of sewer and illuminating gas, that the necessity for careful discrimination presents itself.

"In the future, when the uses of electricity become more general, and its nature better known, it may be that the city of New York will absolutely require a grand electrical underground highway, where space can be provided for the conducting and distributing of sufficient power to run all the engines and work all the machinery within the city limits. It may be, and probably will be, that before such space is needed much more will be known of the qualities of different forms of electrical conductors, and of the best method of carrying them underground, and that the matter of electrical subways will be no longer experimental, but practically demonstrated in every detail.

"When such a time comes the commission or other authority will determine what is required to meet the necessities of the occasion.

"The responsibilities of the present commission begin and end with providing for the requirements of their own day, and for such of the exigencies of the future as they can reasonably anticipate.

"Leaving out of consideration all tunnel systems as too expensive, we must also discard any system which calls for the simple laying of insulated cables in the earth. They would not stand the chemical action of the gases and acids; the streets would be continually torn up for new connections and repairs. We are thus shut up to the question of electric subways or conduits, in which the wires or cables, insulated or otherwise, must be placed, and which once laid down should meet all the demands of the present and near future.

"Of conduits it may be safely predicted that so far as the experience of this and other cities is a test, some form or other of a "drawing-in" system is most convenient. The life of the best cable is by no means satisfactorily decided, and, of any particular cable, to predict how long it would last would be purely speculative. Of wires not contained in cables it may be said that they are equally or more uncertain in their length of life and usefulness. At all events, for purposes of distribution, it is desirable that the wires should be easily approached at frequent intervals, and the commission cannot countenance any plan that looks to the disturbance of pavements more than is absolutely necessary.

"It may be that through lines of wire could be better protected laid in permanent beds of insulating material; but a 'drawing-in' conduit system allows space to be provided for new wires without the frequent tearing up of pavements.

"The commission can, therefore, give their approval to a 'drawing-in' system with frequent man-holes as the general form of subway best adapted to meet the requirements of the electrical service of the present."

Up to this time it was the general impression, which had not been contradicted by experience, because there was none, that the conduits must be built of a non-conducting substance, and not of metal, because the latter would be liable to chafe through the insulation on the wire and cause a ground, and because the companies using the more delicate currents—particularly the telephone company—declared positively that the presence of the large mass of surrounding metal would interfere by induction with the working of their wires.

The best known plan at this time for building ducts of insulating material, and without the use of metallic tubes, was the Dorsett system, which had been laid to some extent in Chicago.

This consists of a bundle of parallel tubular ducts about two and a-half inches in diameter, built of blocks formed of a combination of coal tar, pitch and fine gravel, cast with tubular openings running through them from end to end. These blocks were placed together, end to end, with

* Abstract of paper to National Electric Light Association.

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the holes in line so as to form continuous tubes or passages, and were cemented together by pouring a mastic, softer than was used in making the blocks, into the cracks between them. The blocks were made to adhere to this by warming their ends with hot irons and allowing them to cool after the mastic was poured in. To prevent the melted mastic from closing the ends of the passages, tubular pieces of metal or paper were inserted in the ducts at the ends of the blocks, making a sort of internal sleeve coupling. The conduits so formed terminate in brick manholes at the street crossings.

The objections to this material, as it was afterwards found, are that it is brittle, porous, requires care in laying, and, having no elasticity, cracks with changes of temperature, so that it is not likely to be made water-tight with average workmanship.

But a conduit was laid in New York, according to this plan, on Sixth-avenue, from Twenty-third to Fifty-eighth streets, a distance of 1·6 miles. And the objections were then found, as far as arc circuits were concerned, that its numerous joints were liable to open, and it might leak as indicated above.

The next plan proposed for New York was to use a somewhat similar mixture without requiring it to be made so hard, with the object of preventing its cracking, and to preserve the openings or ducts by casting this bituminous mastic, or mixture of bitumen and sand, around long pasteboard tubes. But no tubes could be found which would not absorb moisture, and the heat of the mastic caused the tubes tried to swell up and disintegrate. The manufacturers of indurated fibre wares were confident that satisfactory tubes could be produced, but it required special machinery and a long time for experiments. Tin and sheet-iron linings were then suggested, but objected to, on account of the difficulty of making good joints. Zinc, however, was considered unobjectionable, and an experiment duct of the Averil system, consisting of soldered zinc tubes in bituminous mastic was laid in the yard of one of the manufacturers ; but it was found that the heat of the mastic melted the solder of the tubes. This difficulty was met by substituting a lap or fold over-seam, and then it was found that the heat of the mastic also affected the nature of the zinc, impairing its durability. On account of the certainty of the zinc tubing rusting and finally crumbling away, it was next thought best to insure the permanence of the bore of the ducts by substituting for the soft mastic some substance which would set, after being poured in, and become hard and durable. For this purpose a hydraulic cement concrete filling was substituted for the mastic. And then a line was laid in Fifty-eighth-street. In laying, the thin zinc tubing was found very frail, liable to be dented in handling, and therefore undesirable. But it was thought that the concrete would maintain a hard, solid, smooth bore, even after the thin sheet metal lining had rusted out.

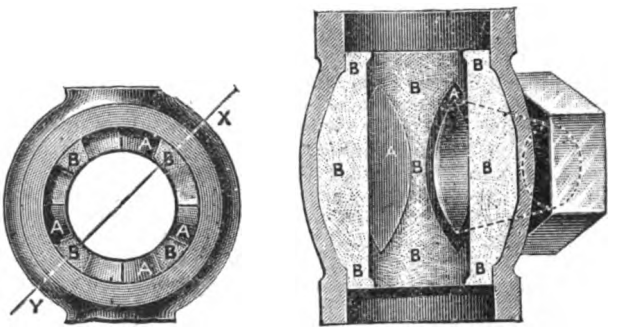
After a thorough investigation and discussion of all the different materials, and the advantages and disadvantages of each, it was finally concluded that a conduit or subway for electrical conductors was merely a mechanical protection for the wires to be placed therein, and should afford the very best protection possible to be procured, while the electrical protection or insulation might safely be left to the manufacturers of cables and wires to be placed in subways.

It was decided that the use of metallic tubes would not seriously interfere, by induction, with the working of the wires, and were to be preferred because the continuous conducting shield so formed will carry off any escaping current and prevent damage to other cables. Accordingly, conduits of iron gas-pipe embedded in concrete were put down, and these seem to be about the best kind so far constructed. They are best, first because there are plenty of workmen who understand gas-pipe fitting and laying concrete, and because they are durable and entirely non-combustible. The purpose of the cement is to prevent the iron from rusting, which it does very effectually. If in time the pipes are destroyed by rusting from the inside, the solid hydraulic cement concrete will remain, furnishing a permanent duct with a hard smooth bore.

(To be concluded.)

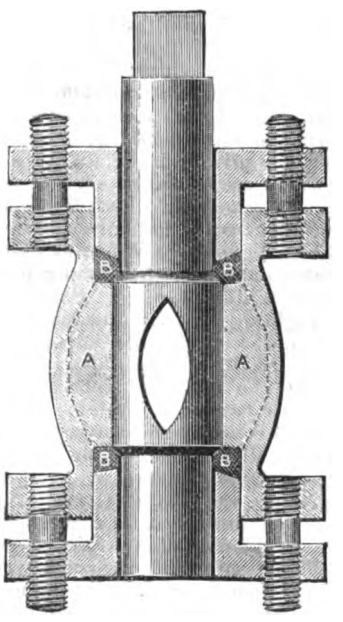
BELL'S NEW PATTERN OF COCKS AND GAUGES.

Messrs. Bell and Co., of asbestos renown, are introducing a new pattern of cocks and water-gauges, manufactured under Baum's patent, and packed with asbestos. The construction is illustrated in the annexed engravings. The plug is parallel, and works on all its faces in contact with asbestos, there being no metal-to-metal friction on any part exposed to the fluid in the pipes. Through the shell there are cut four vertical grooves, B B, designed to provide an easy flow for the asbestos from the glands towards the centre. Each groove is wide-mouthed at each end, and tapers towards the middle. But its cross-section is the same at



Plan. Section through X Y.

all points, the groove becoming deeper as it grows narrower, and thus there is no check or hindrance to the progress of the asbestos, as it is forced forwards to take up the wear. In the views the groove B is shown both in section and elevation, the solid metal between the grooves being indicated at A. There is a shoulder at each end of the plug, and against this there bears a ring of asbestos, which not only serves to make a joint round the shank of the plug, but



Sectional Elevation.

also to feed the grooves. It is sufficient to remove the glands and add asbestos below them to take up leakage round the plug. Screwing down the glands merely affects the packing, tightening it, or, in the case of leakage, taking the same up. Asbestos is becoming more largely used in this direction as its value is appreciated.

ELECTRIC LIGHTING: ITS PRESENT POSITION AND PROSPECTS.

A lecture upon this subject was delivered at St. George's Hall, Langham-place, on Sunday last, 21st., by Mr. Wm. Lant-Carpenter, B.A., B.Sc., before a large and aristocratic assemblage.

In his opening remarks the lecturer said that the subject of electric lighting had an important bearing upon the social welfare of mankind. In New York it was considered that every arc lamp was worth a policeman, and the lamentable state of affairs

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in Whitechapel could not have existed so long if the district had been better lighted. As regarded the sanitary aspect of the question, they all knew that buildings, shops, rooms, &c., lighted by electricity were in a much freer condition from carbonic acid and other products of combustion in the air than they would be if gas were used. There was also very little risk of fire. One of the reasons why electric lighting had not at present made greater progress had been the wild promises which had been made by inventors of primary batteries. People had been told that batteries could be supplied which would require no attention whatever. They merely had to purchase the article and put it in their cellars, and the whole thing was done. The sooner this fiction was exploded the better it would be for the prospects of electric lighting. Within the last few years enormous improvements had been made in the construction of dynamos, particularly with regard to their electrical commercial efficiency, which between 1882 and 1887 had been increased from 67 to 93 per cent., while the weight, bulk, and cost had been correspondingly reduced. The dynamo of the present day was almost a perfect machine. People who were at present reluctant to take up the matter would endeavour to justify their position by saying that they would wait until the whole thing had been brought to perfection. To this he would reply that as far as commercial efficiency was concerned perfection had almost been reached, and that no further improvements were likely to be made in that direction, though possibly the weight, bulk, and cost might be further reduced. There were, as they knew, two systems—the arc and the incandescent. With regard to the comparative cost of the two systems, as against gas, he might say as to the arc lighting that if they took into account the number of candle-power which was produced, the arc light, under almost any conceivable set of conditions, was much cheaper than gas light. The reverse, however, was the case with the incandescent. He might incidentally mention the enormous saving of time and consequent expense effected by the use of electric light on ships passing through the Suez Canal at night, the result of which had been an annual saving to maritime commerce of £100,000. In consequence of the improvements in ventilation which had been made in coal mines, the velocity of the air had been considerably increased, the effect of which was to make the Davy lamps decidedly dangerous. Here the electric light stepped in, and a syndicate was now bringing out a portable lamp (a specimen of which was shown in action) which, it was thought, would remove all liability of danger from contact with the flame and anything which might cause explosion. The lamp in question weighed 4½lb., and would burn for twelve hours, and immediately the glass front was broken by accident or opened by design the light would go out. Several illustrations were given of private installations—notably those of Messrs. Pears, where accumulators were used, and of Baron Rothschild's mansion, at Tring, where there were no accumulators, but a duplicate set of machinery, dynamos, &c. The installation of the arc light at the Waverley Station, Edinburgh, was also instanced, and where the cost per hour of each lamp had been reduced to a little over 1½d. Since the passing of the recent Electric Lighting Act, the question of central station lighting had assumed considerable importance. When the question of central station lighting first arose, electrical engineers were met by the wide and difficult question of distribution. There were two great systems of distribution, the first of which was known as the battery or storage system, and the second as the converter or transformer system. High potential currents would travel over very small wires, and the higher the pressure the smaller the wire. But these high pressure currents were dangerous for domestic lighting, and the Board of Trade would not allow a higher pressure in volts than they considered safe, and engineers were then face-to-face with the problem of finding some means whereby a high-pressure current could be converted into a low-pressure current before it was safe for the supply to enter a house. There were, then, two systems introduced, one much older in point of time than the other, the battery or storage system, which required continuous currents, and the transformer or converter system, which required alternating currents. (In this latter connection several lantern photographs were exhibited on the screen illustrative of Messrs. Gaulard and Gibbs's process.) There was, of course, one objection to an alternating current machine, and this was that it could be only used for lighting, while a continuous current machine could be used for either lighting or motive power. The recent Electric Lighting Act, of course, materially improved the prospects of the industry, and, indeed, might prove to be the turning-point in its history, inasmuch as it offered inducements to capitalists to put their money into new ventures, but still it was felt that new electric light companies were not given the same advantages as new gas companies. Since the passing of the Act in question at least thirty stations had been not only projected but actively pushed forward, notably in Kensington Court (where the plant had recently been tripled), at Chelsea and at various other places in London, the whole of the business part of Liverpool, at Bradford, at Leamington, and elsewhere, and these were all on the battery system, while transformer stations had been projected for Chatham and elsewhere. There were several towns which had not quite made up their minds, notably Tunbridge Wells, Southampton, Reading, &c., while Brighton, Hastings, and other towns already had their installations. As they knew, there were at present several overhead wires in connection with the electric lighting industry, but all electrical engineers were agreed that for permanent work there was no question about it that wires must be laid underground. One of the obstacles in the way of overhead wires was the extreme difficulty of getting wayleaves. From this cause the Grosvenor Gallery installation could proceed no farther east than the Gaiety Theatre. There had been considerable progress made in the direction of electric lighting abroad, and even Honolulu, in the Sandwich Islands, had its installation. One of the reasons of the rapid progress it had made in the United States was the high price the Americans had to pay for gas, for which the usual charge was two to two and a-half dollars per 1,000ft. He would give them some instructive figures as to the extent of electric lighting in the States. There were no less than 5,350 electric plants and stations, about 1,925,000 arc lamps, about 2,250,000 glow lamps, absorbing together about 460,000 h.p. Four or five factories can turn out 10,000 incandescent lamps in a day. The lecturer referred incidentally to the two great patent cases which had been recently heard, and suggested that, instead of these very technical disputes being tried in the usual way in a court of law by the orthodox judge, the matter should be left to the decision of experts in the same way as naval questions were. It had been truly said that the first two or three days of the hearing of the cases in question were occupied in "educating the judge," which was rather a costly proceeding for those who had to pay the piper. A gentleman of his acquaintance, of high repute in the electrical world, had said that at the present time there was one great obstacle standing in the way of the great extension of the electric lighting industry—namely, the natural conservatism of the English nation, which showed itself most strongly in the opposition of local and municipal authorities to all attempts in the direction of co-operative supply. The lecturer concluded by saying that if this country were to take the lead in the future application of electricity to lighting, its common sense would have to be reawakened, and this could only be done by the spread of general knowledge upon the subject.

ON THE TRANSFERENCE OF ELECTRICITY WITHIN A HOMOGENEOUS SOLID CONDUCTOR.*

BY SIR WILLIAM THOMSON.

Adopting the notation and formulæ of my previous paper [given in our issue of October 5] and taking ρ to denote 4π times the electric density at time, t, and place (x, y, z), we have—

$$\rho = \nabla^2 \Psi = - \text{“}v\text{”}^2 \int \left(\frac{d\,u}{d\,x} + \frac{d\,v}{d\,y} + \frac{d\,w}{d\,z} \right) dt \qquad (17)$$

and, eliminating u, v, w, Ψ by this and (16) from (10), we find, on the assumption of κ constant,

$$\kappa \frac{d}{d\,t} \nabla^2 \rho = \frac{d^2 \rho}{d\,t^2} - \text{“}v\text{”}^2 \nabla^2 \rho \qquad (18)$$

The settlement of boundary conditions, when a finite piece of solid conductor, involves consideration of u, v, w, and for it, therefore, equations (17) and (12) must be taken into account; but when the subject is an infinite homogenous solid, which, for simplicity, we now suppose it to be, (18) suffices. It is interesting and helpful to remark that this agrees with the equation for the density of a viscous elastic fluid, found from Stokes' equations for sound in air with viscosity taken into account; and that the values of u, v, w, given by (17) and (10), when ρ has been determined, agree with the velocity components of the elastic fluid if the simple and natural enough supposition be made that viscous resistance acts only against change of shape, and not against change of volume without change of shape.

For a type-solution assume—

$$\rho = A\ E^{-qt} \cos \frac{2\pi x}{a} \cos \frac{2\pi y}{b} \cos \frac{2\pi z}{c} \qquad (19)$$

and we find, by substitution in (18)—

$$q^2 - \frac{\kappa}{L^2} q + \frac{\text{“}v\text{”}^2}{L^2} = 0 \qquad (20)$$

where—

$$L^2 = 1 \Big| 4\pi^2 \left(\frac{1}{a^2} + \frac{1}{b^2} + \frac{1}{c^2} \right) \qquad (21)$$

Hence, by solution of the quadratic (20) for q—

$$q = \tfrac{1}{2} \frac{\kappa}{L^2} \left\{ 1 \pm \sqrt{\left(1 - \frac{4\,\text{“}v\text{”}^2 L^2}{\kappa^2} \right)} \right\} \qquad (22)$$

[In the communication to the section numerical illustrations of non-oscillatory and of oscillatory discharge were given.]

* Paper read before the British Association at Bath.

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COMPANIES' MEETINGS.

MAXIM-WESTON ELECTRIC COMPANY.

An extraordinary general meeting of the Maxim-Weston Electric Company, Limited, was held on Friday last at the Cannon-street Hotel, Mr. John Marks (chairman) presiding.

Mr. Samuel James Boyce (the secretary) having read the notice convening the meeting the following special resolution, passed on the 3rd inst., was unanimously confirmed: "That the capital of the Company be reduced from £125,000, divided into 500,000 shares of 5s. each, to £62,500, divided into 500,000 shares of 2s. 6d. each, and that such reduction be effected by cancelling capital which has been lost, or is unrepresented by available assets, to the extent of 2s. 6d. per share upon each of the 312,000 shares which have been issued and are now outstanding, and by reducing the nominal amount of all the shares in the Company's capital from 5s. to 2s. 6d. per share."

Mr. H. R. Jones seconded, and **Mr. W. H. White** supported, the following resolution, which was also passed unanimously: "That this meeting hereby requests and authorises the Directors to issue a circular to the shareholders embodying the remarks of the Chairman, and accompanied by a form of application for shares, and that the shareholders be urged to apply for shares within a week of the issue of the circular, and that the Directors are hereby authorised to go to allotment upon applications being received for not less than 80,000 shares."

A vote of thanks to the Chairman terminated the proceedings.

NEW COMPANIES REGISTERED.

Mines Contract Company, Limited.—Registered by W. P. Gardner, 63 and 64, New Broad-street, E.C., with a capital of £25,000 in shares of £25 each. Object: to purchase, lease, or otherwise acquire land, whether or not for mining purposes, gold mines, mining rights, water rights, electric power rights, or minerals, and timber situate in the United States of America, or elsewhere, and the rights, privileges, powers, easements and appurtenances to the said property appertaining to, or with the same or any part thereof, occupied or enjoyed; to act as agents, brokers, bankers, and do all such other matters and things as shall be conducive or incidental to the objects of the Company. The first subscribers are:

	Shares.
W. Phillips, 108, Fenchurch-street, E.C.	1
A. E. Ann, 63 and 64, New Broad-street, E.C.	1
J. Mather, 8, King-street, Manchester	1
J. S. Porter, Avenall-road, Highbury, N.	1
J. S. Green, 1, Gresham-buildings, E.C.	1
T. Crowder, Auckland-road, Upper Norwood, Surrey	1
G. T. Browne, Bagbie House, Hailing Park-road, Croydon	1

The company is registered without articles of association, and consequently the regulations of the Companies Act, 1862, will apply.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the past week amounted to £5,123.

Indo-European Telegraph Company.—The Directors have declared an interim dividend for the half-year ended June 30 last at the rate of 5 per cent. per annum, free of income-tax, payable on and after November 1 next.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended October 15 were £2,482, against £2,742 for the corresponding period of 1887. The June receipts, estimated at £5,484, realised £5,550.

Western and Brazilian Telegraph Company.—The traffic receipts of this Company for the week ending October 19, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Company, were £4,282.

Consolidated Telephone Company.—The Directors of the Consolidated Telephone Construction and Maintenance Company, Limited, have declared an interim dividend at the rate of £5 per cent. per annum, less income-tax, for the current year, payable on and after November 14.

West India and Panama Telegraph Company.—At the approaching half-yearly meeting of this Company the Directors will recommend a dividend of 12s. per share on account of arrears on the first preference capital, placing £2,000 to the reserve fund, and carrying over £1,255.

Eastern Telegraph Company.—The Eastern Telegraph Company announce the payment by interest warrants, on November 1, of interest for the half-year ending October 31 on their four per cent. mortgage debenture stock. The books will be closed from October 27 to November 1, both days inclusive.

Western and Brazilian Telegraph Company.—The report of this Company for the half-year ended June 30 states that the total earnings amounted to £86,874, as against £81,419, and the working expenses, exclusive of renewals of cable, to £32,813, against £33,412. The Directors recommend a dividend on the ordinary shares of 2 per cent., or at the rate of 4 per cent. per annum, carrying forward £3,293. At the corresponding period the dividend was at rate of 2½ per cent. per annum. In the case of shares which have been divided into preferred and deferred, the whole of the dividend now recommended will be payable to the preferred shareholders who are entitled to the payment in each year of 5 per cent. "in priority to any payments to the holders of deferred ordinary shares."

Brazilian Submarine Telegraph Company.—The report of the Directors of this Company for the half-year ended the 30th June states that the revenue amounted to £109,548 and the working expenses to £21,385. After providing for debenture interest, sinking funds, and income-tax, there is a balance, including the sum brought forward, of £86,539. The Directors recommend a final dividend of 3s. per share, making, with the interim dividends, a total of 6 per cent. for the year, and also a bonus of 2s. per share, both tax free, which together will amount to £32,500, being a distribution in the aggregate of 7 per cent., leaving £4,539 to be carried forward.

PROVISIONAL PATENTS, 1888.

OCTOBER 12.

14,687. **An improved portable electric lamp, applicable also for house lighting.** John Lowe, Harry Marvin Abbott, and George Gwilt, 1, Sutherland-road, Bow, E.

14,691. **Improvements in telephone central-station apparatus.** Theodore Newton Vail and John Ashby Seely, 321, High Holborn, W.C. (Complete specification.) [Date applied for under Section 103 of the Patents, &c., Act, 1883, 20th April, 1888.]

14,703. **Improvements in apparatus for automatically regulating electric currents.** Peter William Willans, 24, Southampton-buildings, London, W.C.

OCTOBER 13.

14,731. **A siren actuated by electricity.** Francis Henry Nalder, Herbert Nalder, Charles William Scott Crawley, and Alfred Soames, 132, Horseferry-road, Westminster.

14,741. **Improvements in the application of electricity to the propulsion of tramway cars and railway trains, or of other vehicles and canal or other boats.** Thomas Pease, 32, Holborn-hill, Higher Tranmere, Cheshire.

14,772 **A meter or apparatus for measuring the strength of continuous or alternating electric currents.** George Frederick Redfern, 4, South-street, Finsbury, London. (Lucien Brillié, France.) (Complete specification.)

OCTOBER 15.

14,789. **Improvements in applying electricity to the driving of tramway cars, railway or road carriages, barges, or other boats.** Thomas Pease, 32, Holborn-hill, Higher Tranmere, Cheshire.

OCTOBER 16.

14,829. **Improvements in portable galvanic batteries.** William Joseph Starkey Barber-Starkey, 70, Market-street, Manchester.

14,843. **Improvements in electric meters.** Joseph Oulton and Joseph Edmondson, Town Hall Buildings, Halifax.

14,888. **Improvements in electric cranes.** Thomas Drake Hollick, 35, Southampton-buildings, Chancery-lane, London, W.C.

OCTOBER 17.

14,901. **Electric heat and fire detecter test board, and is part of number 14,790 of 15th October, 1888.** Benjamin Anderson Dougherty, 128, Amersham-vale, New Cross.

14,910. **The regulation of electrical induction coils.** Samuel Arthur Lovick, 204, Burton-road, Derby.

14,924. **An improved incandescent electric lamp.** Ernst Böhm, 53, Red Lion-street, Clerkenwell, E.C.

14,932. **Improvements in and connected with portable electric incandescent lamps and batteries.** Samuel William Maquay, 55 and 56, Chancery-lane, London.

14,941. **An electrical apparatus for the prevention of burglaries in dwelling-houses.** Arthur Gauge, 166, Fleet-street, London.

OCTOBER 18.

14,963. **Improvements in electric bells and signals, and in appliances for use therewith.** Edward Cox-Walker and Alan Archibald Campbell Swinton, 75, Queen Victoria-street, London, E.C.

14,979. **Improved electrical brake and apparatus for automatically actuating same.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C. (Complete specification.)

14,981. **Improved method of and apparatus for actuating printing machinery by means of an electric current, and instantaneously checking or arresting the motion thereof when required.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C. (Complete specification.)

14,982. **Improved method of and apparatus for operating turntables for railways and other purposes by means of an electric current.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E C. (Complete specification.)

14,983. **Improvements in telpher lines, or elevated suspended railways, and vehicles and locomotives therefor.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C. (Complete specification.)

14,984. **Improved method of and apparatus for rotating hydro-extractors by means of a current of electricity, and automatically checking or arresting the motion thereof when desired.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C. (Complete specification.)

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14,985. **Improved method of and apparatus for utilising a current of electricity for operating pile driving machinery, and rendering the action of same automatic.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C. (Complete specification.)

14,986. **Improved method of and apparatus for applying electricity as a motive power to cranes, shear legs, and the like.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C. (Complete specification.)

14,987. **Improvements in fans, air propellers, and the like, and method of operating the same by means of an electric current, and apparatus therefor.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C. (Complete specification.)

14,988. **Improvements in "mashers" and "mixers" as employed in brewing and other processes and method of and apparatus for applying electricity as a motive power for same.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C. (Complete specification.)

14,989. **Improvements in steering apparatus for ships, and method of, and apparatus for utilising electricity as a motive power for same.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C. (Complete specification.)

15,008. **An improvement in electric arc lamps.** James Fyfe, 28, Southampton-buildings, Chancery-lane, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

OCTOBER 24, 1887.

14,445. **Improvements in the insulation of submarine telegraphic cables and other electrical conductors.** Reginald Haddan, 18, Buckingham-street, Strand, London, W.C. (Emil Georg Prillwitz, Germany.)

14,461. **Improvements in electric accumulators or secondary batteries.** Albert Stetson, 6, Lord-street, Liverpool.

OCTOBER 29, 1887.

14,729. **An improved meter for measuring electrical currents.** William Henry Douglas, 7, Cherry-street, Birmingham.

OCTOBER 31, 1887.

14,834. **Improvements relating to the regulation of steam-engines and other motors for working dynamo-electric machines or electric generators.** William Robert Lake, 45, Southampton-buildings, London. (Carl Ludwig Rudolph Ernest Menges, The Netherlands.)

NOVEMBER 5, 1887.

15,118. **Improvements in electric incandescent lamps.** Wm. Clarke and Charles Algernon Parsons, of the firm of Clarke, Chapman, Parsons and Co., 46, Lincoln's-inn-fields, London, W.C.

NOVEMBER 19, 1887.

15,922. **An improved spring jack for telephonic and other electrical purposes in which it is desired to change or switch a current from one conductor to another.** Alfred Coleman, Hubert Feilden Jackson, and Ernest Leonard Dudley, "Dulâs," Stanmore-road, Edgbaston, Birmingham.

NOVEMBER 25, 1887.

16,217. **Apparatus for automatically conveying and delivering letters and small parcels by electricity.** Frederick Charles Allsop, Bexley, Kent.

DECEMBER 3, 1887.

16,643. **Improvements in apparatus for indicating static or dynamic force or other measurement on prepayment of a coin.** Frederick Charles Lynde, 4, St. Ann's-square, Manchester.

DECEMBER 7, 1887.

16,863. **Improvements in or connected with means for the automatic electrical distribution and charge of secondary batteries.** Frank King, 47, Lincoln's-inn-fields, London.

DECEMBER 14, 1887.

17,175. **Improvements in phonographs and phonograms.** George Edward Gouraud, 191, Fleet-street, London. (Thomas Alva Edison, United States.)

JANUARY 2, 1888.

20. **Improvements in the entire or partial propulsion of velocipedes and other light vehicles by means of electro-motors worked by primary batteries.** John Sherrin and John Vaughan Sherrin, Codrington-road, Ramsgate, Kent.

AUGUST 29, 1888.

12,455. **Improvements in the application of primary batteries and electro-motors to tricycles and other velocipedes.** John Sherrin and John Vaughan Sherrin, 77, Chancery-lane, London, W.C.

SEPTEMBER 8, 1888.

12,986. **An improved electric or galvanic sponge or pad for stimulating and curative purposes.** Randal Cresswell, 97, Newgate-street, London.

SEPTEMBER 12, 1888.

13,192. **Improvements in or relating to bleaching by electrolysis.** Emile Marie Hippolyte Andreoli, 62, Loughborough-park, Brixton, S.W., Surrey.

SPECIFICATIONS PUBLISHED.

1887.

10,009. **Electric railway signals.** G. H. Wright. 11d.
13,080. **Dynamo-electric machines.** W. Fritsche. 1s. 1d.
15,385. **Disinfecting impure liquids by electrolytic action.** E. Hermite and others. 8d.
15,532. **Electricity.** S. Joyce. 8d.
15,555. **Electric motors.** W. M. Mordey. 8d.
15,583. **Electric tramways and railways.** B. J. B. Mills. (Edison.) 8d.
15,660. **Electric clocks.** A. J. Thomas. 8d.
15,801. **Incandescent electric lamps.** W. H. Beck. (Michel.) 11d.
16,305. **Voltaic cells.** H. C. Donovan and T. Weatherall. 8d.
16,458. **Electric telephones.** A. A. Campbell-Swinton. 8d.

1888.

6075. **Utilising electricity for heating, &c., buildings, &c.** E. E. Ries. 1s. 1d.
9662. **Electrical type-writers.** A. J. Boult. (McLaughlin.) 8d.
11,108. **Electric conductors.** P. M. Justice. (Acheson.) 8d.
11,411. **Dynamo-electric machines.** A. W. Meston. 8d.
11,779. **Galvanometers.** E. E. De Facieu. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	4¼
12 Feb.	2/0	— fully paid	5	5¼
27 July	1%	Anglo-American	100	48⅛
27 July	2%	— Pref.	100	80
12 Feb., 85	5/0	— Def.	100	17½
28 June	3/0	Brazilian Submarine	10	13½
14 June	1/0	Con Telephone & Main	1	⅞
10 Aug.	9/0	Cuba	10	14
10 Aug.	10/0	— 10% Pref.	10	18½
12 Oct.	2/0	Direct Spanish	5	4
12 Oct.	5/0	— 10% Pref.	5	10½
27 July	2/0	Direct United States	20	10½
12 Oct.	2/6	Eastern	10	12⅜
12 Oct.	3/0	— 6% Pref.	10	14⅞
1 Aug.	5%	— 5%, 1899	100	110
26 April	4%	— 4% Deb. Stock	100	110
12 Oct.	2/6	Eastern Extension, Australasia & China	10	13⅛
1 Aug.	6%	— 6% Deb., 1891	100	104½
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	105
28 Mar.	8/8	German Union	10	9½
12 Oct.	3/0	Globe Telegraph Trust	10	7
12 Oct.	3/0	— 6% Pref.	10	14¼
30 April	5/0	Great Northern	10	14

Dividend.		Name.	Paid.	Price. Wednesday.
1 March	5%	Gt. Northern 5% Deb., '83.	100	103½
27 July	10/0	India Rubber, G. P. & Tel.	10	17
11 May	37/6	Indo-European	25	39½
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅜
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
.....	...	Swan United	3½	2½
10 Aug.	13½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	98
12 July	4/0	West Coast of America	10	8
30 June	8%	— 8% Debs.	100	115
11 May	9/0	Western and Brazilian	15	13½
11 May	6/10½	— Preferred	7½	7½
11 May	2/1½	— Deferred	7½	5½
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
.....	...	West India and Panama	10	1⅜
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80	...	— 6% 2nd Pref.	10	10⅜
2 May	7%	West Union of U.S.	$1,000	125
1 Mar.	6%	— 6% Sterling	100	102

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NOTES.

Madrid.—The shares of the Madrid Gas Company (500f.) have gone up from 380f. to 480f. on their determination to take up electric light as well as gas supply.

Channel Fleet.—A public illumination of the Channel Squadron took place at Liverpool on Wednesday evening, the electric flash-lights evoking great enthusiasm from the crowds.

Portable Lamps.—Small portable hand-lamps, with battery and reflector, are beginning to be seen in the various West End shops, and prove very useful for a number of purposes.

Cape Cables.—Private advices from Africa state that the cable ship "Amber" has been sounding for, it is supposed, a continuation of the West Coast cables towards, or possibly to, the Cape.

Personal.—Mr. David Marks has resigned the office of director of the Schanschieff syndicate, being about to proceed to Australia, and Mr. T. Grant Wells has been appointed secretary *vice* Mr. John Wright.

Acme Electric Works.—We are requested to mention that the Acme Electric Works are now under the management of Mr. Arthur C. Cockburn, M.S.T.E., instead of Messrs. Cockburn and Day, as heretofore.

Otley.—The Otley Board have been encouraged in their design of introducing the electric light by the inspection of the printing works of W. Walker and Sons, of Otley, who have a 300-light plant fixed by Roper and Co., of Bradford.

A Washable Motor.—Mr. Sprague is engaged on the problem he has set himself to produce—a motor which he will be able to clean by washing down with a hose, and an armature which can be left to soak in a tub of water overnight.

Stroud.—The residence of Mr. Alfred Appleby, at Stroud, has been lighted by Messrs. Drake and Gorham, a gas-engine and Elwell-Parker dynamo being used, and regulation obtained by the use of one of their 50-light storage batteries.

Birmingham Tramways.—The Central Tramway Company made experiments on Tuesday with the tramcar driven with electric motor. The bearings ran hot near the end of the journey, but the experiments are so far considered satisfactory.

Society of Telegraph-Engineers.—The next meeting of the society will take place at 25, Great George-street, on Thursday next, November 8, at 8 p.m. Mr. W. Lant-Carpenter, B.A., B.Sc., on "Ocean Temperature in Relation to Submarine Cables."

Humboldt Electric Mining Company.—The prospectus of a company under this name is to be issued next week. The company owns three of the mining properties of the Consolidated Esmeralda. The power will be transmitted to electric motors by electricity generated at the river.

Deptford.—"Is it your opinion that this station will be a success?" The question has been put to us over and over again since the appearance of our article, and in every case our reply has been to the effect that, so far as opinions can be formed at present, the consideration of the work points most emphatically to success.

The Cox-Walker Swinton Bells.—The Equitable Telephone Association have received an order to fit a number of these magneto-electric bells on the fast cruiser "Piedmonte," now building on the Tyne for the Royal Italian Navy. The absence of any batteries will prove a great advantage on board ship.

Mordey Alternators.—Several of the new alternating machines designed by Mr. Mordey have been manufactured for further central station electric lighting. Two of these are for the Brush Company's new station at Bournemouth, two for Devonshire, one for a town on the south coast, and two others have been sent abroad.

Electro-Harmonics.—The first smoking concert of the Electro-Harmonic Society, third season, which took place last Friday, at St. James's Hall, Regent-street, was a splendid success. Over 300 were present, thoroughly enjoying the very high-class music provided, and the chance of meeting, over a chat and a smoke, their colleagues in the field of force.

Swansea.—The surveyor has been directed to obtain information and report on the extent of works for public lighting that can be erected by the corporation for an annual expenditure of £4,060, and the town clerk has been instructed to obtain a provisional order for lighting a portion of the borough by means of electricity. This question was referred to in our issue of October 12.

Business.—Messrs. Paterson and Cooper are as busy as they can be, and are thinking of extending their factory. Orders are in hand for dynamos representing over half a million watts. Firms in the North assure us of constant and increasing activity. The field for motors is vast, and has not been tapped to any very great extent yet, but we are hearing of proposed central motor stations.

Twelve-inch Spark Machine.—Another large Wimshurst machine, similar to that made for testing the Deptford cable, is being made by Messrs. Mayfield, Cobb, and Co, to be sent to the Paris Exhibition. The machine has eight 30in. plates, and gives a spark of 12in. It will be on view shortly at Budge-row to scientific inquirers for some little time before sending to Paris.

Personal.—We are requested by Mr. A. A. Campbell Swinton to state that his appointment as consulting electrical engineer to Messrs. Sir W. G. Armstrong, Mitchell and Co., of Elswick, which we mentioned last week, in no way interferes with his position as manager of the Equitable Telephone Association, which position he will still retain, and that his address will continue to be 75, Queen Victoria-street, E.C.

Messrs. Allen and Co.—We understand that this firm, the well-known makers of the Kapp dynamo, are about to extend their electrical department, and have engaged Mr. Kempster, who has had considerable and successful experience in installation work, to manage their installation department. It has been somewhat surprising that this firm, having so good a machine, has not previously gone into such work.

Westinghouse.—The announcement is made of the annexation by the Westinghouse Company of the Consolidated Company and the Sawyer-Man Company. The Westinghouse Company will, therefore, have absolute control of the lamp trade hitherto conducted by these companies, and will be able to manage them in the direction of greatly extending their already very large business in dynamo and lamp making.

O.S.A. Papers.—We understand that the Old Students' Association has been promised a paper by Albion T. Snell,

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of Messrs. Immisch and Co., on the construction of electric motors. A paper by such an authority, even though it will not be able to go into secrets belonging essentially to the firm, cannot fail to be extremely interesting at the present time, and we may expect an enthusiastic audience of visitors, as well as of students. The paper is to be read, we believe, at the Central Institution, at South Kensington.

Central Lighting in the City.—The arrangements for the City electric light station undertaken by Crompton and Co. are, we understand, progressing favourably, large numbers of orders having come in spontaneously. There seems to be very little, if any, persuasion necessary to convince of the immense superiority of electricity over gas for office work. In fact, at the present time electricity seems to be about the only commodity that requires no pushing in order to sell. Everybody seems anxious to have it at the earliest possible moment.

Contracts Wanted.—We have received the following from the Information Department of the London Chamber of Commerce: The following is a translation of a paragraph which appears in a report of the Belgian Consul-General, on openings for the investment of foreign capital in the Canary Islands: "Electric lighting is also wanted at St. Croix (Teneriffe) and Las Palmas (Grand Canary), and a contract would be made with a company willing to undertake it. It is the same for the telephone for the various towns of these islands." The full report may be consulted at the offices of the Chamber, Botolph House, Eastcheap.

Electric Prostration.—Several cases of this new malady are reported from Creusot, France. It affects workers under electric light. The light exceeds 100,000 candle-power, and it appears that it is this excess of light, and not the heat, which produces the nervous symptoms. A painful sensation in the throat, face, and temples is first noticed, then the skin becomes coppery red, and irritation is felt about the eyes; much lachrymation ensues, and these symptoms then disappear, whilst the skin peels off in five days. The effects are comparable to those produced by walking over fresh snow in the sunlight, and may be regarded as a sort of "sun-burning."—*Lancet.*

Bath.—The report of the committee, as referred to in our issue of last week, was unanimously adopted, with the addition, "That the corporation shall have the power to buy the whole of the plant, at the end of seven years, at a fair valuation." It is somewhat curious to see, after the educational process which the people of Bath have undergone, the total, or almost total, reversal of feeling with regard to the electric lighting. Those who were somewhat bitterly opposed to it in the early stages have been converted to the way of thinking of Mr. Massingham, and it speaks much for the energy of that gentleman that he has been so successful in obtaining the support of his own townsmen.

Vibrations of the Camera.—According to Ch. Moussette, most of the peculiarities noticed in photographs of lightning flashes arise from accidental vibrations caused by the wind, the thunder, or the shaking of the earth. In order to prove this he made a white on black drawing of flashes inclined at different angles. This drawing was photographed in two ways—first, with the camera carefully secured from vibration; secondly, with the camera slightly jerked at the moment of photographing. In the first case the flashes came out fine and clearly defined; in the second case the flashes presented the appearance of striated ribbons, except where the lines of the drawing were parallel to the direction of motion of the camera.

Change of Title of the Society.—A special general meeting of members of the Society of Telegraph-Engineers and Electricians will be held at the Institution of Civil Engineers, 25, Great George-street, Westminster, on Thursday, the 8th day of November, 1888, at 7.45 o'clock p.m., when the following resolutions will be proposed: (1) "That the name of the society be changed to 'The Institution of Electrical Engineers.' (2) That the office of honorary secretary be abolished, and that the articles of association be altered by omitting all reference to the honorary secretary in articles 36, 38, 40 and 43.'" Should the resolutions be passed by the required majority, they will be submitted for confirmation as special resolutions to a second special general meeting of members, which, in the absence of further notice, will be held on Thursday, the 22nd day of November, at the same place and time. It will be interesting to our readers to learn that out of 846 replies to the circular issued to members of all classes, in February last, 837 express approval of the proposed change of title.

Electricity is Truth.—An incident happened last Saturday at Manchester which illustrates the moral effect of an electric shock. A certain Mr. Smith was discovered in a railway carriage senseless and ticketless. Being conveyed to the infirmary he recovered consciousness, but neither his ticket nor his power of speech. In fact, he declared in writing that he was both deaf and dumb. The doctors seem to have had strong doubts upon this point, and tried the application of electricity. The first shock Mr. Smith received from an induction coil not only enabled him to speak, but also to speak the truth. "My name is Smith," said he, "and you may put me down a rogue." "Great and many are the virtues of electricity," remarks the Manchester paper. "If certain politicians could only be compelled to make their speeches while in touch with a galvanic battery, we should evidently have more trustworthy history from them." The acumen of the doctors was applauded, and the value of electricity as a moral touchstone is now widely advocated.

Pulsatory Currents.—A suggestion which has been embodied in a patent by Gustave Pfannkuche, depends for its effect upon a pulsatory continuous current in the place of an alternate current. The inventor contends that it is just the same whether you have a variation of E.M.F. on one side of the zero line, or a variation of E.M.F. which is the sum of the variations on the opposite or negative side of the zero line. Thus by a pulsatory current which has a varying E.M.F. of 50 volts, you would get the same effect from a converter as from an alternating current which had that variation. The advantage claimed for a pulsatory over a continuous current is that arc lamps and motors working at the medium line of the pulsation could be run on the same mains as converters, and that also electro-deposition might be carried on. The available E.M.F. which the pulsatory current develops is the average of the varying potentials, and if the pulsations be sufficiently frequent, the action of an arc lamp, or motor, or depositing vat would be the same as acted by a continuous current having this amount of E.M.F.

A Closed-in Car for Electric Railways.—A car for electric railway purposes has been introduced on some of the American lines, in which the platforms are formed

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into bow-windows. The object of this is to protect the car driver and the levers by which the car is controlled from the weather, and from the interference of passengers or persons not upon the car. The bow-windows really serve about the same purpose as the pilot house aboard ship. In addition to the above, the doors of the car are hung in the sides of the bow-windows, and it is the intention to use the doors at one end only at a time, thus freeing the driver from all hindrance. Another feature of this improved car is the double-brake mechanism. Two brake shoes work against each wheel. They are controlled independently of each other, and one only is used except when sudden stops are made, or one fails to work. The motor is placed at one side of the car between the axles, and is covered with a box which extends up to the car windows, and about one half the distance across the car, leaving passage way for the passengers from one end of the car to the other. The car was designed by Mr. Edmond Verstraete, of Chicago.

Contracts for Exeter Refused.—At the last meeting of the Exeter Town Council, the mayor (Mr. Roberts) presiding, a report was considered from a special committee on electric lighting. The committee opened tenders for lighting the selected district by electricity as follows: Exeter Electric Light Company, sixty-five arc lamps, 1,200 c.p., £19. 17s. 6d.; wires, £3; total per lamp per annum, £22. 17s. 6d. Messrs. Allen and Son, Taunton, sixty-five arc lamps, 1,200 c.p. (Thomson-Houston)—overhead, per lamp per annum, £24; underground, £28. 10s.; Brockie-Pell or Pilsen-Joel, 1,000 c.p., £21 and £25. 10s. respectively. Messrs. Newall and Co.—Thomson-Houston, 1,200 c.p., overhead, £23. 10s.; underground, £27. 10s.; Brush, 2,000 c.p., £25. 10s. and £29. 10s. respectively. Messrs. Sharp and Kent, 2,000 c.p. lamps, £35 and £40. Anglo-American Brush Electric Light Corporation, Limited, 2,000 c.p. lamp, overhead, £43 per annum. The whole of the above figures were on a seven years' basis. The committee pointed out that the lowest tender represented a cost of £1,486. 17s. 6d. per annum, while the present cost of lighting the same district by gas was, according to the surveyor's report, £666. 11s. 8d. The total illuminating power of the existing gas lamps at the posts would be 2,000 c.p., while that of the electric light would be 32,000 c.p. Having regard to the large increase in the cost, as compared with that of gas, the committee did not recommend that any of the tenders be accepted, and the council concurred.

Bradford Electric Lighting Works.—What was described as the foundation-stone of the Bradford Electric Lighting Works, in Canal-road, was laid on the 26th ult. by Alderman Frederick Priestman, chairman of the Gas Supply and the Electric Lighting Committee, in the presence of a large number of spectators. The mayor presented Alderman Priestman with a silver trowel and mallet, both of beautiful design, with which to perform the ceremony of laying the stone. Canon Bardsley asked a blessing on the work, and Alderman F. Priestman performed the ceremony with the usual formality. Addressing the assemblage, he observed that he should ever be pleased to have his name associated with the electric works, as he felt sure electric lighting would become a great commercial industry, and Bradford would have the honour and distinction of being the pioneers in the work. The works were in a forward state, the cables were in Bradford, and the other portions of the machinery necessary were so near completion that he hoped the works would be finished at the beginning of next year. Alderman Priestman said that Mr. Shoolbred thought they would be completed about the middle of December. Concerning the price to be charged, he said it was not the intention of the committee to supply anything but the electric current, and customers would have to make their own arrangements for the fixing of lamps of whatever power they required with other engineers. In supplying the current it would be charged either by meter, or the numbers of hours the light was used, and if intending customers would only take the trouble to see Mr. Shoolbred and explain the kind of light they intended having, he would give them an idea of the cost. Alderman Priestman said that Bradford was to be congratulated on ordering its plant when it did, for since then the price had considerably increased. Votes of thanks to the mayor, Alderman F. Priestman, and the Vicar of Bradford brought the proceedings to a close.

Lyndhurst Electric Tramway.—With reference to the recent discussion of the Highway Board on the proposed electric railway at Lyndhurst, Mr. I. W. Haynes, C.E., one of the promoters, dating from 27, Chancery-lane, has written to the *Hampshire Advertiser*. He says: "It appears to me that the chief objections raised to our scheme may be summed up as follows: (1) That it will be a nuisance. How this can arise I am unable to see, as the cars will run smoothly and practically noiselessly over the rails. There will be no smoke, nor puffing, as with steam-engines; there be will not even the commotion of an ordinary omnibus in starting or stopping, and its silent movements will not in the least disturb the normal state of quietude and retirement of Lyndhurst and its surrounding. (2) That it will frighten horses. This is the bogey invariably brought out at every introduction of a proposed tramway. It shows the weakness of our opponents' case, when such childish talk is indulged in. The best answer to this objection is that electric tramways, and even steam tramways, are actually in existence, and regularly running, in streets and roads in London and other towns where the traffic is very large, and in some places enormous. These tramcars run actually *along the roadway* over which the other traffic has to pass, whilst in the case of the Lyndhurst tram the line will not be on the roadway at all, but on the waste, and some distance from the former. The promoters claim that such lines of tramway are in the interest of horses, and the fact is emphasised by the remarks of a select committee of the House of Commons in this connection, made so far back as the year 1877, by which it was placed upon record that 'Common humanity loudly demands some other motive power than horses.' (3) Danger to cattle. How can it possibly be of danger to cattle—unless, indeed, a cow should happen to charge one of the tramcars, in the belief that they are encroaching on its proper domain—when the car is so completely under control that it can be stopped in much less time than an ordinary cart or 'bus? It will not be running at express speed like the Flying Dutchman, but at the modest rate of six to eight miles an hour (which is the maximum speed allowed by the Board of Trade), and the rate of an ordinary omnibus." The writer presses the one important question involved as being "whether the inhabitants of Lyndhurst desire better means of communication," and adds that "to condemn the scheme because it is proposed to relieve the road by running an omnibus on rails, and propelling it by mechanical means, instead of using

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animal power (always to be avoided when practicable), appears unreasonable."

Institute of Medical Electricity.—A conversazione to inaugurate the opening of this institute took place on Tuesday last, attended by distinguished visitors. An address of welcome on behalf of the directors of the institute was delivered by Mr. W. Lant Carpenter, who explained the objects of the institute—namely, to provide establishments where electrical treatment can be obtained under the direction of qualified medical advisers; to encourage physiological investigation with a view to the further development of curative electricity, and to provide medical men with trustworthy electrical apparatus and instruments for the diagnosis and treatment of disease—the rooms being free to qualified practitioners at all times. An interesting exposition was given by Prof. Silvanus Thompson of "Old and New Views of Magnetism." The lecturer described the importance of the early investigations by Dr. Wm. Gilbert, Queen Elizabeth's physician, who devoted considerable time and much of his private money to the science of magnetism, and might be considered the father of modern investigation, practising, as he did, the inductive method before Bacon taught it. His beautiful and simple experiments were hardly, if at all, surpassed by Faraday. Prof. Thompson explained the latest theories of magnetism as probably the resultant of electric currents continually circulating in the atoms, or even, we may perhaps eventually believe, the atoms themselves being closed circuits of electricity. The opening of the medical institute was an appropriate occasion for a tribute to a Court physician who had done so much to advance the science of magnetism. Medical electrical apparatus and objects of similar interest were exhibited during the evening, the institute exhibiting specimens of its switch-boards, large induction coil, milli-ampere meter, rheometer for measuring resistances by telephone, cauteries, and various electrodes, laryngoscopes, &c. Surgical operating lamps were lent by G. T. Dent, Esq., Messrs. Coxeter and Son showing primary and storage batteries, cystoscope, and lamps for illuminating cavities. Messrs. Woodhouse and Rawson showed various instruments for measurement, standard lamps, &c., and Messrs. Paterson and Cooper also exhibited their ammeters and voltmeters. Messrs. Mayfield, Cobb, and Co. had on view their dry batteries, portable electric bells, and Wimshurst machines. Messrs. Beck and Son showed microscopes, Messrs. Carpenter and Wesley stereoscopes, &c., and the Stereoscopic Company all kinds of photography for medical purposes. Music and conversation made the evening pleasant and interesting, and the institute may be congratulated on their successful start, and in the progress of their work they have our best wishes.

Electric Fire Brigade at Stockport.—Speaking at a Radical meeting in Middle Ward on Monday night, Councillor Atherton referred to the new fire alarms now in course of construction in Stockport. Having, he said, witnessed the precautions against fire in some of the places he had visited, he found when he entered the council that Stockport was very far behind in this respect. The Americans, for instance, had appliances which would more than surprise some people. When in Newark, on one trip, he had the pleasure of seeing the whole of their wonderful fire extinguishing arrangements. They had electric communication with the fire-stations from various parts of the town. Immediately an alarm was given a large gong was struck at the fire-station. The clock was stopped to show the exact time the alarm was given, and if it was in the night the gas was turned up by electricity. Stable doors were thrown open by the same means, out came the horses, which showed remarkable intelligence, and took their places, one on each side of the pole of the engine. The harness, which had been suspended in order and readiness, was lowered by an electric arrangement on to the horses' backs, and their collars were self-clasping. By this time an indicator worked by electricity in combination with the gong had registered the particular part of the town where the fire had broken out. The driver sprang on the box, took up the reins, the doors were thrown open by another ingenious arrangement, and off they went. He saw all this done in nine seconds from receiving the alarm. In order to be prepared for alarms in the night, the men slept on the fire-station premises in an upper storey. Before retiring, their coats and hats were placed on the fire-engine. For night work they were provided with boots about two sizes too large, and these were placed beside the bed, with the pants pushed into them, so that the men might jump into their pants and boot both feet at the same time. The bed coverings were removed from the men by an electrical arangement, and, to avoid wasting time in going downstairs, the men slid down a brass pole about 3½in. diameter through an opening in the door, and the time occupied from the receipt of an alarm in the night to the engine being on its way to the fire was 15 seconds. It should also be mentioned that on receipt of an alarm the fire was ignited in the fire-box of the steam fire-engine by the same current of electricity that gave the alarm, although there was already pressure on the boiler generated by a steam connection from a fixed boiler in the cellar of the fire-station. This steam was instantaneously disconnected by electricity on receipt of the alarm without the slightest waste of steam. They had also just added to their appliances a chemical fire-engine that required neither fire nor furnace, no steam being needed, as the boiler was charged with chemicals, which by locomotion through the streets *en route* to the fire caused an action on the chemicals and produced a pressure 800lb. to the square inch. This is a similar principle to that adopted in the fire-extinguisher carried on the back in mills in this country, but, of course, developed considerably. It seemed to him that Stockport should be placed on a better footing as regarded its appliances for giving notice at the headquarters of the fire brigade when fire broke out in any part of the town, and the ready way in which the watch committee took the matter up was very gratifying. Stockport has now wall boxes for telephones, by which notice can be given in four seconds instead of fifteen minutes previously necessary to convey the news by foot, and, of course, the first few minutes after an outbreak of fire are all-important. When the system of fire alarms was completed to the satisfaction of the committee, it would be superior to anything the sub-committee found elsewhere, and he considered they had down their duty to the town in this respect.—We are glad to find Stockport is inaugurating a better system of electric fire-alarms, although it does not appear that Stockport is yet going to entirely imitate Newark (U.S.). We have never understood why it is that practical adaptation of electricity to the fire brigades in this manner has not taken place in all the principal towns of England, and we trust the enthusiasm of the worthy councillor may lead to the extensive adoption of the American system.

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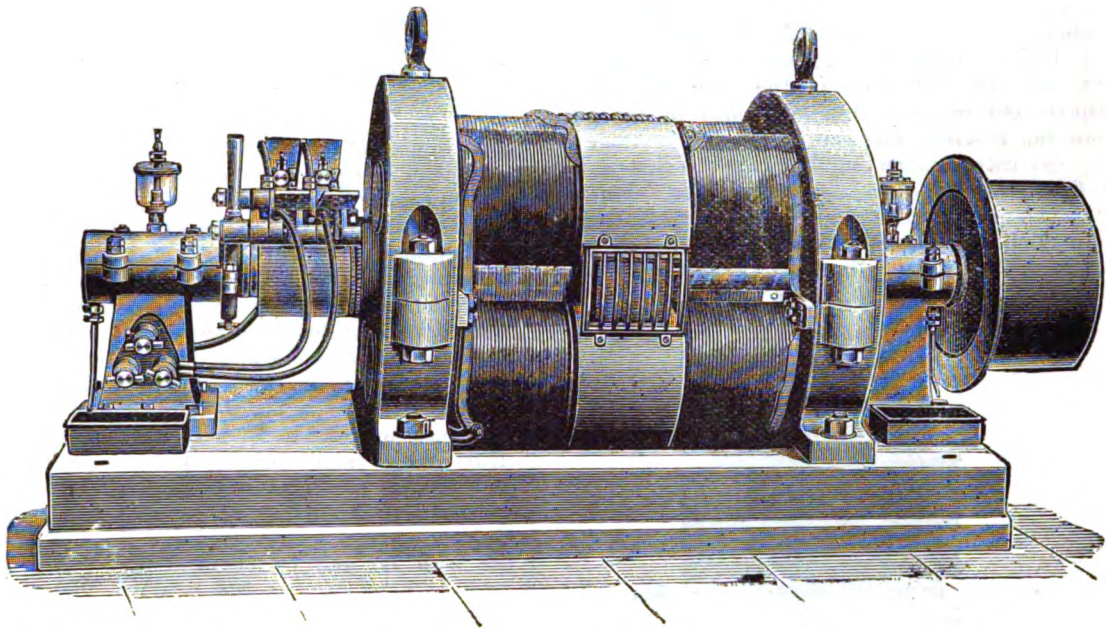
ELECTRICAL ENGINEERS.

III.—THE GULCHER ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

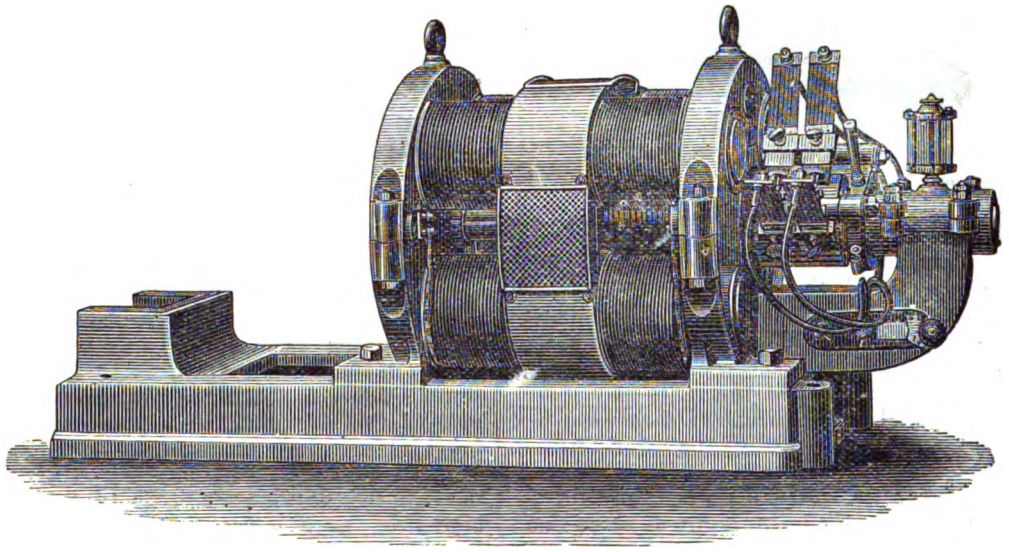
Among our electrical engineers who have been undertaking large electric lighting contracts, the Gulcher Electric Light and Power Company, Limited, has continued to secure a very large amount of the electrical engineering work going, not only in England, but in various other parts of the world. Amongst the large manufacturing concerns in the North, installations by this company are constantly to be met with, and such names as Sir W. G. Armstrong, Mitchell and Co., Cadbury Bros., Brooks' Cotton Mills, and the Coalbrookdale Company, are a few of the best known names of factories lit by the Gulcher Company. A central station has been fitted up by them at Yokohama, Japan, and two more are in progress in New Zealand.



New Type Gulcher Dynamo.

There is no doubt that this company has passed through various vicissitudes, which threatened, at one time or another, the whole of the original electric lighting companies, but, unlike so many of its *confreres*, a steady adherence to the policy of undertaking practical work on a paying basis, instead of relying too much upon its patents, has enabled this company to pull through and to take its place as one of the recognised electrical engineering concerns. Recently, as is well known, a reconstruction of the company has taken place, the number of directors having been reduced, and more of the practical element introduced, and as it was necessary to make the amount of capital such that it was possible on a reasonable turnover to pay a dividend to the shareholders, the capital of the company was reduced to £40,000 instead of £200,000, and the company continues its work under the name of the Gulcher (New) Electric Light and Power Company, Limited.*

On account of the negotiations necessary for this conversion it has been thought in some quarters that the work of the company was more or less at a standstill during these proceedings, but this has been by no means the case. The work of the company has proceeded, and, as a matter of fact, more has been undertaken during the last year than in any preceding year, and there are more orders on the company's books than ever before. The company employ over 100 men in the works and on outdoor installations, the number rising up to 200 in the busy season. Not a little of its present favourable position is due to the untiring energies of Mr. W. C. Mountain, its able general manager, who has had the advantage (a great one in these early days of electric light) of being born and bred a mechanical engineer. Mr. Mountain has now practically the whole business of the company under his control, as well as designing the dynamos and generally superintending the engineering requirements of the work.



Gulcher Dynamo and Engine Bedplate.

The company was originally formed to work the British patents for a dynamo and arc lamps taken out by Mr. R. J. Gulcher, of Biala, near Bielitz, Austria, who was the first to introduce the system of running in parallel arc lamps on a low tension circuit; but, although the company still

* It has been determined in future to spell the name of the company in the English way, without the diæresis over the "u."

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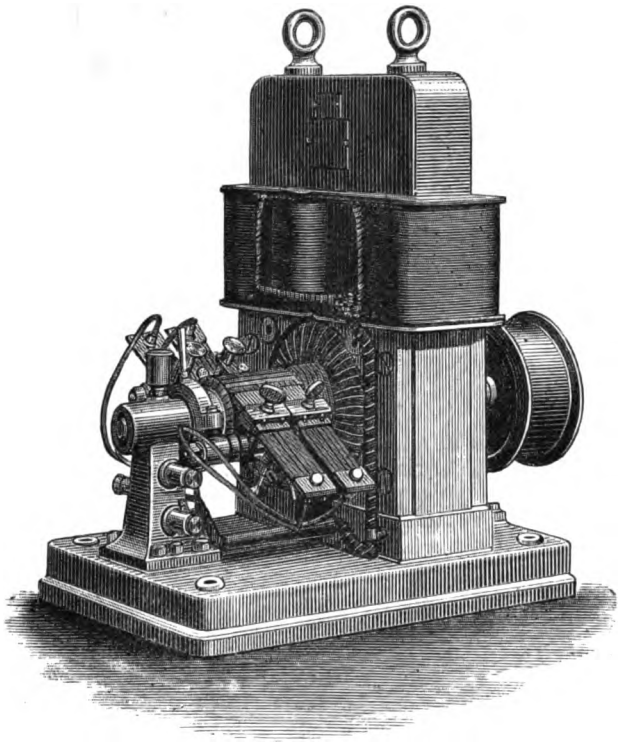
makes the system of lamps in parallel a speciality, they no longer confine themselves to any one system of running, and supply dynamos for all purposes, series machines (and series arc lamps), and machines for depositing and refining metals and for transmission of power, and have also recently been doing a considerable amount of work with alternate current dynamos and transformers for high tension circuits, in addition to the original system of parallel arc and incandescent lighting covered by the Gulcher patents. These new manufactures are all from designs made by Mr. Mountain.

Description of the Works.

The works of the Gulcher Company are situated at Battersea, where they have leased half of Messrs. Ransome, Jeffries and Wood's extensive premises known as "Battersea Foundry," on the south side of the Thames, just over the Battersea old bridge, and best reached by the penny 'bus from the Sloane-square station of the underground railway. On entering the building we see first a large ground floor workshop—the dynamo erecting shop and turnery. This is occupied with heavy lathes, turning, planing, and shaping machines engaged upon the heavy



Two-Pole Gulcher Dynamo.

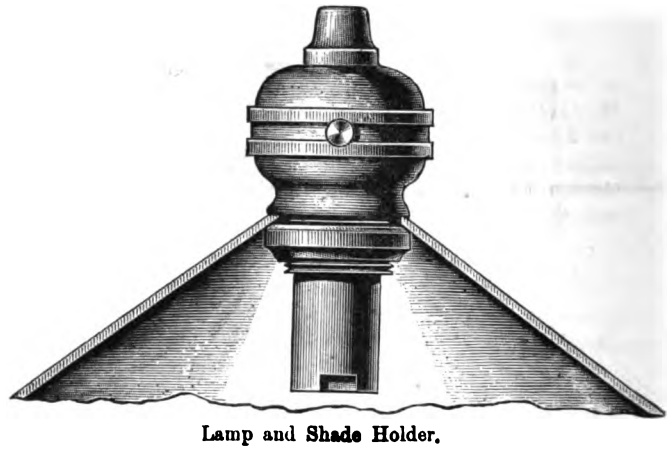
work of the dynamos, field-magnets, pole-pieces, and iron bed-plates. The large number of special machine-tools laid down by the company enable them to do all the necessary work in their own shops, and also render them independent of other firms for such apparatus as fittings, switches, &c., so that they are able to turn out installations complete in all electrical details (with the exception of the cable and wires), designed for the special requirements of each case, and securing the advantage of having the workmanship executed under their own supervision.

Screw-cuttting machines and milling machines occupy one corner of the shop for the manufacture of screws and terminals. A special wood-cutting machine is employed for making wood casing, of different shapes and sizes, used for running the electric conductors in the various installations undertaken by the company. In the dynamo shop there are a number of the standard pattern of Gulcher dynamos, ranging from 10 up to 200 lamps, in stock, ready for immediate delivery, and others are in progress. We notice three large dynamos, giving up to 50 units, at 105 volts, for incandescent lighting. One of these is for Armstrong, Mitchell and Co., and the two others for the large clothing factory of Arthur and Co., of Leeds. Four large "Gulcher" alternating machines are also in hand for 500 lights each at 1,500 volts, to be installed at two central stations for use with transformers for the street lighting of Wellington, New Zealand, where they will be driven by water-power by the means of turbines. Lyttleton Harbour, in that colony, has been lighted by Gulcher dynamos for over four years, and six other dynamos, of 15 to 20 units alternating currents, will be supplied for private lighting. A 15 unit plant is also being supplied for a somewhat out-of-the-way place—namely, an iron works in the extreme north of Sweden, within the Arctic circle, where the night in winter lasts continuously for several months, and the dynamo will be required for constant running.

In the winding department we see numerous armatures, and field-magnets for the different dynamos, in process of being wound with insulated copper wire. One speciality in the form of armature for the Gulcher dynamos is that the core, instead of being laminated by being built of plates of sheet iron in the usual way, is made up of iron *wire*, of a rectangular section, single cotton covered, and wound solidly together to form the core; the copper conductor being then wound at right angles to the core.

The engine and boilers used for driving the works are situated at one end of the main workshop. The engine is a Ransome's stationary horizontal engine, with automatic governor, indicating 75 h.p. Steam is supplied from two Cornish boilers working at 50lb. pressure. The whole of the works is lighted by electric light, arc and incandescent, from the shop dynamo, and this method of illumination is entirely relied upon to the exclusion of gas.

The offices are on the ground floor, and above them, on the first floor, we come to the brass turning and finishing shops, fitted with small turning lathes, screw cutting lathes, and milling machines, and here all the brass parts used in construction are turned out and fitted together. The Gulcher Company make a large number of switches for use with arc and incandescent lamps, and also a special



Lamp and Shade Holder.

exchange switch for use in connecting up dynamos running together in parallel, and this we shall further mention. Here, also, are made the well-known Gulcher arc lamps, a simple and satisfactory arc regulator. Simple adjustable resistances on slate bases with iron covers are made for use in conjunction with these arc lamps. The arc lamp stores contain a number of Gulcher lamps finished and ready tested for use, and a large carbon store is also provided for storing the quantities of carbon rods constantly supplied to installations fitted with their lamps. Passing through the drawing office—that necessary adjunct and head-piece, as it were, of all engineering concerns—we come downstairs again to the testing-rooms. In one place the dynamos are fixed on completion, and a trial run taken. From this point cables are led to the testing-room itself, where a large switch-board enables any required tests to be made. A Siemens dynamometer is used for the usual current measurements, and Ayrton and Perry's ammeters, registering up to 700 amperes, for the output of dynamos. A series of wires are led from the switch-board to a large resistance, composed of carbon rods and placed overhead, having a large radiating capacity. Apparatus for testing resistances is also provided with a Wheatstone bridge and galvanometer. In the next room the arc lamps are tested and regulated before sending away. A number of arc lamps can be lighted together for testing, and each lamp requires

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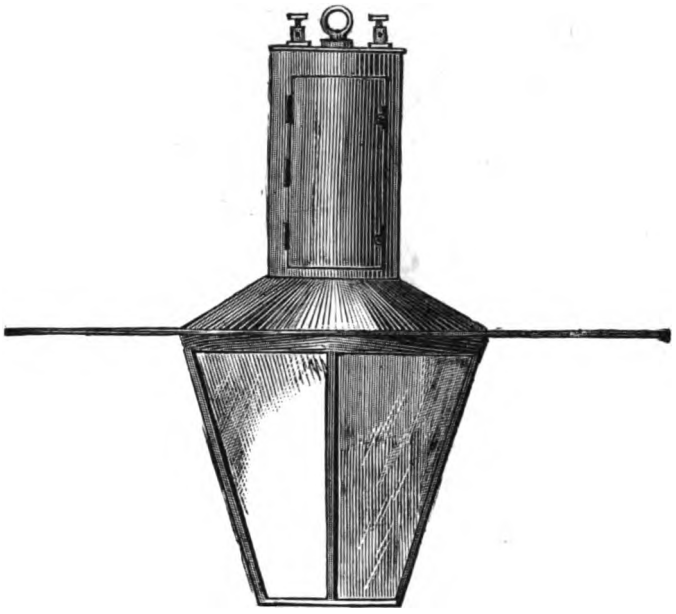
about twenty minutes' attention in order to adjust exactly the pull of its regulating magnet.

The Gulcher Continuous-Current Dynamo.

The appearance of the Gulcher dynamo is shown in the illustration. Two iron side frames have the iron cores of the field-magnets bolted to them, and between these the disc-shaped armature revolves. These dynamos are made, usually for 105 volts, to supply from 30 to 2,000 incandescent lamps of 16 c.p., or from 3 to 100 2,000-c.p. arc lamps. The brushes are double or treble, with separate springs, admitting of adjustment of one brush while the other is still in contact, and the dynamos can be run continuously night and day, if necessary, without stoppage. The arrangement of winding of the dynamos renders it unnecessary to adjust the brushes from a full to a light load. When compounded, these machines give an almost perfectly straight line of equal potential under current loads varying from nil to the full carrying capacity of the wire with which it is wound. The armature core is built up by winding on a gun-metal hub charcoal iron wire of square section and cotton covered. This is wound on layer after layer until an ample sectional area is attained, calculated for a magnetic density of 23,000 lines of force per square inch. By this means very complete lamination at right angles to the flow of current is secured, and as a consequence the Gulcher armatures never get heated by Foucault currents. The gun-metal hub is keyed to the shaft



Gulcher Arc Lamp—Factory.

and also prevented from working loose laterally by nuts screwed on to the shaft. A very powerful magnetic field is provided for the armature to run in, the field-magnets being made of ample sectional area and of the best wrought iron. The bearings of these machines are of phosphor bronze, and great attention is paid to their accurate boring, and to further ensure absolute truth they are carefully scraped. Only the best cast iron is used for the framework of the Gulcher dynamos, and all surfaces which form part of the magnetic circuit are accurately planed, so as to reduce the magnetic resistance of all joints to the lowest possible value. The commutators are made from bar copper of V section, and mica is used for the insulation. The sections are put together with the insulating strips in position between each section, and the whole is clamped together with wrought-iron clamps, and is then tested carefully for insulation. The sections, turned up true and finished, are mounted on a sleeve having a fixed ring on one end with a coned inner edge; this edge fits into a corresponding groove turned in the ends of the sections, and a coned washer slips over the other end of the sleeve and fits into another groove turned in the other end, and is tightened up by a nut screwed on behind it. Both the nuts and the sleeve are, of course, insulated from the sections. The bed-plate is hollow and webbed, and carefully planed on its under edges as well on all the upper surfaces on which the bearing pedestals and magnet side frames rest. The pulleys are flanged on the inner side and curved on their surface. They are bored taper, and the shaft is turned to fit, and the pulley is set up tightly with a nut. All copper used in these machines is of at least 98 per cent. conductivity. The standard type of Gulcher machine is four-pole, and a very neat arrangement is adopted to reduce the number of brushes from four to two. As is well known, all that is necessary is to connect each wire leading from the armature coils to the commutator to the one diametrically opposite to it. This is effected in the Gulcher dynamo by covering a short length of the shaft between the armature and commutator with a wooden sleeve, and mounting on this a number of brass washers equal to half the number of armature coils, and each provided with two diametrically opposite lugs. Asbestos insulation is inserted between each pair of washers. The lugs are notched, and each pair of wires from opposite coils rest on its way to the commutator in the notched lugs of one washer, and the wires are cleaned and soldered in position. The brush-holders themselves are models of neatness, and are provided with an ingenious little arrangement for fastening them back clear of the commutator when desired. Both

Gulcher Arc Lamp—Ornamental.

brush-holders are fixed on a carrier ring, sliding on the periphery of a fixed disc, and provided with a handle and set screw for adjustment.

The great modifications recently introduced by Mr. W. C. Mountain into the design and construction of the Gulcher dynamos have enabled the company to turn out a machine of the highest efficiency both electrically and mechanically, and at the same time have considerably reduced the cost—as much, in some cases, as 20 per cent.; so that these machines are now cheaper and far more efficient, and will compare favourably with the most recent type of machines. One of the practical improvements introduced by Mr. Mountain consists in bolting the frames of the machines to the bed-plate instead of making them solid therewith, in such a way that whenever it is desired to couple direct to a high-speed engine for ship lighting, for instance, it is not necessary to have a separate bed-plate for the dynamo itself, but it can be lifted and fastened to the engine bed-plate. This, of course, effects a saving of one bed-plate, and makes the work in planing much less.

Two-Pole Gulcher Dynamo.

The smaller sizes of machines are made of the two-pole type, as being more convenient for small machines, having fewer parts. These little machines are very efficient, and are sold in considerable quantities for electro-plating work

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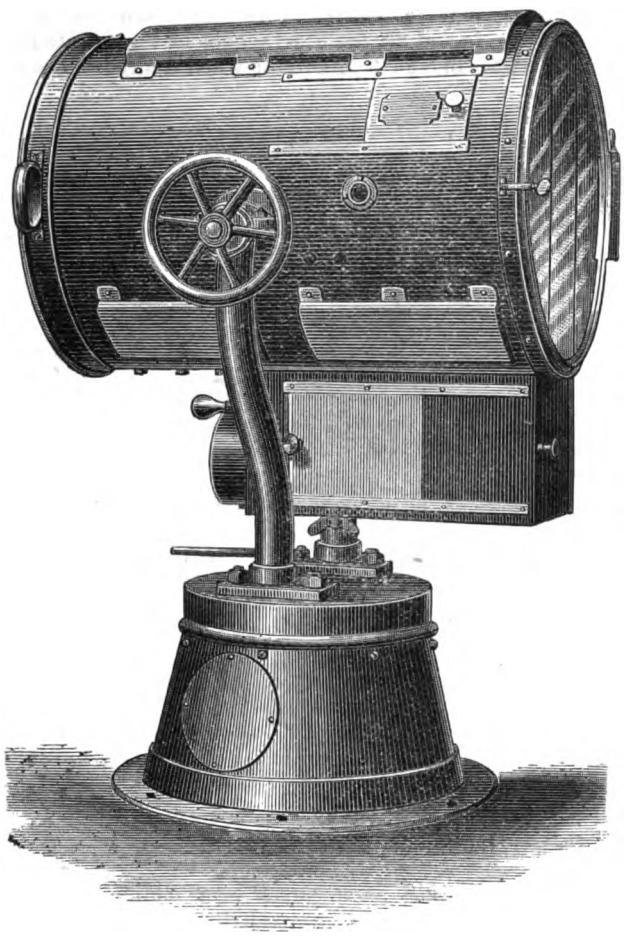
and for motors. Fifteen of them were shown at work at the Bingley Hall Exhibition, distributing power to all the moving machinery used to illustrate a variety of small Birmingham trades, such as diamond cutting, gunstock making, metal spinning, drilling, &c. These machines are made in four different sizes for lighting purposes, and are generally wound to give 10, 15, 20, 25 amperes at 65 volts. The one shown in the illustration gives, however, 30 amperes at 40 volts running at 2,300 revolutions, or 15 amperes at 40 volts at 1,480 revolutions, and it stands 18 inches high.

The Gulcher Arc Lamp.

The company make their lamp in three sizes, viz., of 3,000, 2,000, and 1,000 c.p., taking currents of 15, 8·5, and 5 amperes respectively, at 45 volts across the terminals of the lamp. These lamps are usually fitted with globes, or with a lantern having four sides paned with muffled glass. The globes are carried on a telescopic arrangement, which is very neat, and allows it to be readily lowered for recarboning, &c. Resistances are provided for each lamp for the purpose of equalising the parallel circuits in which these lamps are intended to be connected.



Merchant Service Projector.

Series Dynamo and Lamp.

In cases where the low-tension parallel system of arc lighting is not applicable, high-tension series dynamos are made on the same model as the old Gulcher machine wound to run arc lamps in series. A series arc lamp has been designed to run with these dynamos.

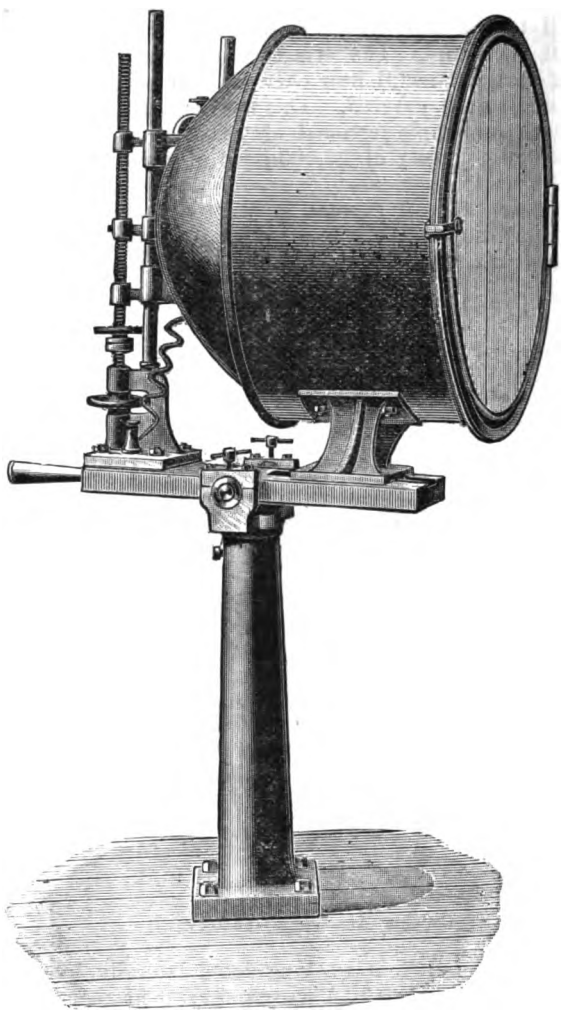
Switches.

The Gulcher Company make a speciality of switch-boards and switches, and the accompanying illustrations show their exchange switch and double-pole switch with cut-outs.

The "exchange switch" is used for connecting dynamos in parallel in such a way that the field magnets of one are run by a shunt from the terminals of the other. In this way one dynamo will never take the greater share of the work, as sometimes happens in the ordinary way of connecting in parallel. By this means one spare dynamo is a sufficient stand-by for a large installation. All switches made at these works are mounted on slate slabs of excellent quality and considerable thickness.

Projectors and Search Lights.

The company have also a special line in projectors and search lights. These they make of three types, and one illustration shows the "Admiralty" type made in every respect to Admiralty requirements and specification. The projector, barrel, and base is of steel, and the elevating and depressing gear and all moving parts are of gun-metal. This projector is made in four sizes, according to the diameter of the Chances mirror with which it is fitted—viz., 16in., 18in., 20in., and 24in. The other two types are the "Merchant Service," and the "Yacht," and are similar except that the slow elevating and depressing gear are omitted, and in the case of the "Yacht" type silvered copper mirrors are used.



Yacht Projector.

This last type is also very handy for masthead work, and has also been used for lighting roads and quarries. Hand-feed lamps are usually employed for these projectors, but automatic lamps can, if preferred, be fitted to them—at any rate for the smaller sizes. The Gulcher Company have designed a very handy special plant, which they call their "Suez Canal" plant. This plant is intended for ready fixing on steam vessels when about to go through the canal at night, and consists of a vertical engine and dynamo on one bed-plate, a cage containing a "Merchant Service" projector and lamp, to be slung over the ship's bows, and a 6,000 c.p. ordinary lamp to be attached to the masthead. The cage is of sufficient size to hold comfortably the projector lamp, a switch-board carrying a voltmeter and ammeter and cut-outs, and still to have room for a seat for the operator behind the projector. A speaking-tube runs from the cage to the dynamo. The bed-plate is fixed in a wrought-iron frame, with L iron corner pieces, and the ends of these L irons are of sufficient height to prevent any risk of damage to the dynamo when slinging. These L irons also carry two small reels of cable for connection. The plant is completed with a length of flexible steam-pipe, for

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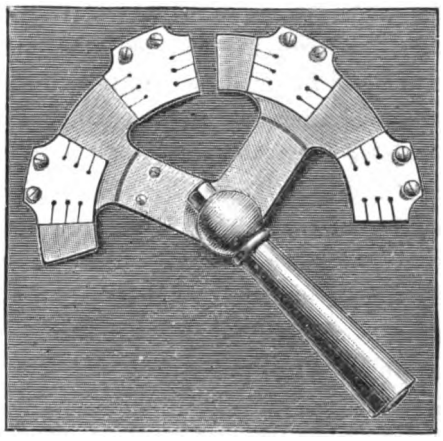
connection to the deck service steam-pipes and another for the exhaust.

The company have also brought out an arrangement for suspending a powerful arc light for photographic purposes. This arrangement enables the operator to move the lamp in every direction or raise or lower it at will with the

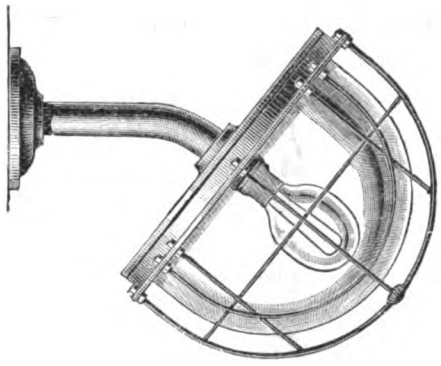


Exchange Switch.

greatest ease, and seemed to be admirably suited to the purpose for which it was intended.

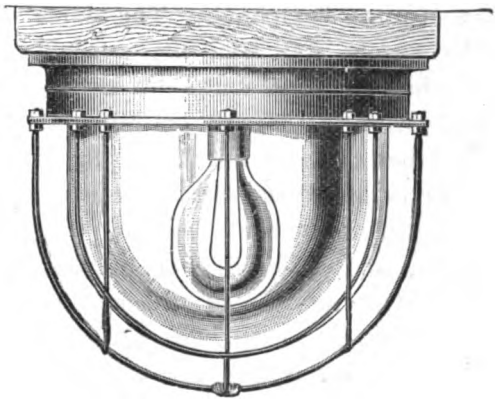
FITTINGS.

The company make their own fittings for workshop, factory, and colliery use, of which we illustrate one or two



Pit-head Lamp.

forms; one of these is for underground working in collieries. A contract has just been secured by the company for lighting the Albion colliery, in South Wales, in this manner. A combined incandescent lamp-holder and



Pit Lamp.

switch is also made, fitted to flexible pendants or to ordinary electric brackets.

ALTERNATING DYNAMOS AND TRANSFORMERS.

The recent development in the transmission of high-tension currents by means of alternating machines for use with transformers, has induced the Gulcher Company to take up this branch of electric lighting, and several large alternating plants with transformers have been supplied. The alternating dynamo is somewhat similar to the low-tension Gulcher machine, but is wound for high tension, and the magnets are arranged for alternate currents. Dynamos of this type are made up to 70 units output, at a difference of potential usually of 1,500 volts. We shall give some further information as to the Gulcher alternating dynamo and transformer, with illustrations, in a future number.

MOTORS.

With slight adaptation, the Gulcher dynamos act extremely efficiently as motors, and have been supplied for various pumping and power-driving purposes. The company have recently constructed a trial electric car—like an open tramcar—for a 2ft. gauge, to carry 12 people, which has been run on a track 150 yards long, experimentally laid down near the works.

DEPOSITING DYNAMOS.

The Gulcher Company also make dynamos for all sorts of metal depositing and refining, and the treatment of ores. The most recent application of these dynamos has been to the deposition of zinc direct from the ore in works at Swansea, the process thus inaugurated avoiding all smelting by heat.

ELECTRIC LIGHTING IN BIRMINGHAM.

The most complete and extensive installation of the electric light which has yet been attempted in Birmingham was successfully inaugurated last Saturday. Corporation-street, Birmingham, is as familiar to all residents and visitors as is the Bank of England to Londoners. The renovation of this part of Birmingham is largely due to the enterprise of the Corporation Street Estate Company, which has just erected a most important block of business premises in the town, at the corner of Corporation-street and Martineau-street. These buildings have been erected from the design of Mr. J. P. Sharp. The block consists of nineteen large shops and basements, with two floors of large and well-ventilated offices above them. The two upper stories of the buildings are arranged for warehouses, work-rooms, or dwelling apartments, as may be required, and access will be given to these rooms by lifts worked by electric motors. The electrical plant has been designed by Mr. T. C. Sharp, and consists of two 50 h.p. semi-portable compound steam-engines, made by Messrs. John Fowler and Co., of Leeds. The dynamos are by Messrs. Elwell-Parker, of Wolverhampton. They are two 40 unit shunt-wound machines, 100 volts at 650 revolutions, driven direct from the above-mentioned engines. Either dynamo can be run for generating current direct to the lamps, or both in parallel if necessary. The same firm has supplied a set of fifty-four B 31 accumulators for an all-night circuit and for day supply to the basement lamps. The dynamos are wound to run up to 125 volts for the charging of this battery. The cables from the dynamos are brought to a central distributing switch-board, from which leads are run to the various floors and shops, there being secondary distributing boards on each landing, and separate circuits for each shop and office. The section of copper wire throughout is heavy, so that there is only a maximum loss of two per cent. at the extreme distance. The switch-boards, cable, and wire have also been supplied by Messrs. Ellwell-Parker. The lamps and fittings have been supplied by Messrs. Fowler and Lancaster, of the Albert Works, Birmingham. When the whole work is complete the number of lamps will be about 1,000 16 c.p. incandescent lamps inside the building, and two 3,000 c.p. Brockie-Pell arc lamps outside. The run on Saturday, to inaugurate the installation, was for five hours, and great appreciation of the light was expressed by the public who witnessed the lighting. For the time being we heartily welcome all such installations as this, feeling that they must rapidly extend, and as they become more numerous will inevitably increase in a more and more rapid manner till electric lighting becomes general and not exceptional. The corporation which initiated and the Messrs. Sharp are to be congratulated on the success of their work.

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BOUND VOLUMES.

Vol. I., new series, of "THE ELECTRICAL ENGINEER" (Vol. IX., old series) is now ready, and can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

EDISON-SWAN.

Of the older electrical companies—that is, those promoted early in the eighties—only two survive that may be said to have achieved success. One, after passing through a chequered career—at one time carried to the giddiest heights of speculative prominence and then down into the deepest depths—finally, by strict attention to business matters instead of speculative, has obtained a firm footing, and its shares stand above par. We refer, of course, to the Anglo-American Brush Company, which really has a unique history, a history which if written would to a few present immense interest. So far as we know, it is the only company that does pay dividends out of business profits. The ill-fated British Company at one time seemed on the wave of prosperity, when to the astonishment of onlookers it went back, and fell out of the race. The how and why of this might be told by Prof. G. Forbes, Mr. R. Ward, or others who were more or less behind the scenes. Who was the Mephistopheles in the case? Whose advice was it that, when followed, led downward instead of upward? There are secrets in the history of the decline and fall of companies which, if they could be rescued from oblivion, would be worth enormous sums in hard cash if from no other reason than that the errors of judgment, or system, of the directors would form a plain warning post to all who followed. Of course a number of companies floated that were never intended to survive—they were the pot boilers of promoters and speculators. How much the electrical industry owes to a few private firms, such as Crompton's, Blakey-Emmott's, Paterson and Cooper, and to companies such as the Silvertown, managed by level-headed men not to be caught by City anglers, will never be truly realised. The Edison-Swan Company and the Brush Company, however, stand out pre-eminently as electric light companies—pioneer companies. The annual meeting of the former was held the other day, the report of which will be found on another page. Unlike the Brush, it is not entirely out of the wood. On the other hand, there is the satisfaction of increasing business and increasing profits—with, however, the awful bugbear of unknown results, costs, and otherwise of litigation. The shareholders, with an earned dividend, are asked to stand aside and forego their just claims in favour of the great unknown. We cannot say the directors' conclusions are wrong, but we can say our belief is that a successful appeal will not be worth the money paid for it. There are certain lamps the makers of which have not been proceeded against, and complete success against one, two, three, half-a-dozen, still leaves others.

A keen business man of great experience who has been continually successful, in that he has

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made fortunes for other folks as manager of their business, delivered himself as to how he would have acted: Law, not likely; threaten as much as you please; the lawyers might write and write, but procrastinate would be the word governing their actions. Meanwhile, work away among the buyers, make and sell a good article as cheaply as possible. Humour the clients, get them on the books, and if you could not keep them there, you would not be worth your salt as a business man. In the commercial manufacture of almost any article, and undoubtedly in that of electric lamps, modifications of the original processes would be devised; patent these and publish broadcast that the product was better when made according to the new patents than under the old. At the expiration of the patents, Tom, Dick and Harry might rush into the manufacture of the article, but they would get no customers, because the latter would prefer the better article under the newer patents. Patent right lasts as long as you want it, rightfully managed. Always have, or make believe you have, a secret in the process. The buyers are not always wise in their generation; but, on the whole, if treated fairly and in a business-like way, the defections would be few and unimportant. A large buyer well served does not change like the small buyer, though every effort should be made to keep the latter, because he may, and a certain number must, become large purchasers.

Briefly these views are put, yet they seem to contain a fair measure of business acumen. The Edison-Swan Company has earned a dividend this year of 8 per cent.; its shares are a long way below par, a feature that could not arise if these questions of litigation were arranged. The business is not likely to decrease; rather the contrary, it should rapidly increase, notwithstanding competition, and a modest 5 per cent. is not too much to expect. The signs of the times point to a rapid extension of the demand for lamps, and surely a company of this magnitude, and with so great accumulated experience should, now it has a large circle of customers, hold them and add to their number. The future prospect may be bright enough, but a deferred 10 per cent. is not the equivalent of a 5 per cent. now obtained. With regard to litigation expenses, it is said of the *Times* that it has long taken the precaution to insure itself against these, and has at the present moment an accumulation of a quarter of a million sterling to fight or defend its legal battles. Might not companies take a leaf out of this book and insure likewise?

BARNET.

We have heard so much of the electric lighting of Barnet, its failure cr its success, that it is time something definite was said about it by someone who is impartial, or who is not prejudiced (to the utter extinction of all ability to see what is there) upon the side of the gas companies. The reports which have hitherto appeared are either based upon or copied direct (!) from the gas papers—our contemporaries of the technical press having evidently found it easier to cut out or comment upon these articles than to visit the place itself.

Now, it is impossible to deny that anyone visiting Barnet, and expecting to see a row of arc lights of immense c.p. and the whole place flooded with light, will be certainly disappointed. But this is not the point. The contractor has undertaken to replace gas by electricity at a similar cost, and he has certainly succeeded in this respect. We visited Barnet without giving any notice to any person, wishing to see the light in its ordinary aspect, and, although we had no instruments, we were able to take some measurements which will serve to give some idea of the working of the installation, and will also show that the statements of the absolute failure of the light and the ridiculous statements emanating from Blyth, and copied into the *Barnet Press*, are simply absurd and ridiculous. We were quite prepared to write the thing down a failure if it were a failure, but this is what we found. On coming out of the station we are still in the region of gas lamps. Small print could not be read from these lamps at a distance of 13 yards. The time by the watch could hardly be distinguished at a midpoint between the gas lamps. Further up the hill we came to the electric lamp-posts—handsome looking posts—with large glass globe and reflector, some feet higher than the gas lamp. The appear- of the lamp was not noticeably different in colour from the gas, but was certainly very much brighter, and the whole row along the street, though not giving a marvellously brilliant appearance, was very considerably better than the gas. This, to the general eye—and to obtain comparison, we found that the same newspaper print could be read at 22 yards from the electric post, and the time by the watch could be quite *easily* seen at a point midway between the posts. Now there is, as we have said, nothing marvellously bright about the lamps, but these tests certainly show, what also appears to the eye, that the light is better than the gas. Light varies as the square of the distance; taking the square of 13, that is 169, and the square of 22, that is 484, it is seen that the electric light is practically three times the strength of the gas. The posts are considerably further apart, in some cases twice as far apart; but, allowing for this, it will be seen there is, at the most moderate computation, at least once and a-half or twice the light. So that, however, we, who are accustomed to see electric light outshine the dull and dismal gas by tens or hundreds, may regret that Barnet did not spend more and be flooded with light, yet it is abundantly evident that if the people of

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Barnet merely wanted a good average light to replace at a similar expense the light of their too confident and grasping gas company, this desire has been fully satisfied. The electric light has taken the place of the gas, gives a good general illumination, and it is mere folly to call such an exploit a dismal failure.

There is little doubt that the people of Barnet expected each lamp to be a 2,000 c p. arc, and are to this extent disappointed, but on enquiry at several places and shops we found throughout (with one exception) pleasure at the light, and a belief in the success of the experiment. As to the failure of the electric light, it went out twice at the beginning of the experiment. How does this compare with the gas company's first start? It is a matter of history that gas went out for a whole week (!) at Barnet at *their* inauguration. The light is now run from a temporary portable engine; two permanent engines of 20 i.h.p. each and dynamos are being fixed for the public lighting, and a few other lamp-posts will be added in outlying districts. Separate engines and boilers are intended to be placed adjoining for private supply, and several hundreds of lamps have already been ordered.

THE MAGNETIC FIELD.—IV.

In article III. it was shown how the repulsion between those magnetic stream-lines which are flowing in the same direction, and the attraction between those flowing in opposite directions must produce a mechanical force between a magnet pole and a straight wire conveying an electric current. The force acts at a right angle to the plane laid through the wire and the pole, and must obviously be proportional to the strength of the current and to that of the pole. It will also be readily understood that the force must depend in some way upon the distance between the pole and the wire, and the following simple experiment shows that the force is inversely proportional to the distance. Let W W (Fig. 6) represent a very long vertical wire traversed by an electric current, and suspend round it a disc-shaped board so that it can freely revolve round the wire as axis. Upon the board fasten a magnet, N S, which, if no other force but the attraction of the earth act upon it, will cause the board to revolve until the axis of the magnet points north and south. If the wire be so long that those portions of the circuit which join it at either end be sufficiently removed from the magnet not to influence it, the latter will not alter its position whether a current be sent upwards or downwards through the wire. The experiment therefore shows that a current in an infinite straight wire produces no rotative effect upon a magnet if the centre of rotation be within the wire. From the property of stream-lines to form closed curves it immediately follows that both poles of the magnet must be equally strong. The turning moment exerted upon the disc by the N pole is proportional to its strength, the strength of the current, and the inner radius of the disc; that exerted by the S pole is similarly proportional to its strength, the strength of the current and the outer radius of the disc, but acts in the opposite direction. Since the two turning moments balance each other, the tangential forces impelling the poles must be inversely proportional to the radii of the disc—that is, to the distances of the poles from the wire. This simple experiment shows, therefore, that the force exerted by a current flowing along an infinite straight wire upon a magnet pole is directly proportional to the product of the strength of the pole and the strength of the current, and inversely proportional to the distance between wire and pole. As in practice we have, however, always to deal with conductors of finite dimensions, we must analyse this case a little further and investigate how each part of the wire affects the pole. In other words, we must find the general law for the force exerted upon a magnet pole by a current in a definite piece of a neighbouring conductor. This law must be of such a character that its application to the special case of an infinitely long conductor gives a result in accordance with the above experiment.

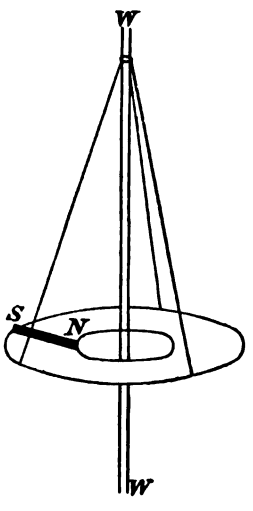

Fig. 6

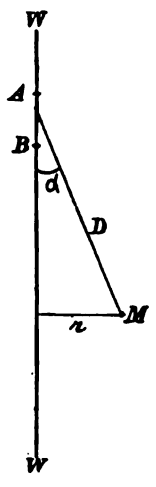

Fig. 7.

The problem, then, is to find the action of an element, A B, of the wire, W W, upon the magnetic pole, M (Fig. 7). Let the length, l, of the element be so small that the distance of M from either end is sensibly equal, namely, D, and denote the strength of the pole by M, and that of the current by c. The force, P, exerted by the current in A B upon M is

$$P = \frac{M l c}{D^2} \sin \alpha . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

because this relation is the only one which satisfies the special case of the infinite wire. If the element be infinitesimally small, we can write $l = d\alpha D / \sin \alpha$, and by substituting $r / \sin \alpha$ for D we have

$$d P = \frac{M c \sin \alpha \, d\alpha}{r},$$

which, integrated between the limits $+\frac{\pi}{2}$ and $-\frac{\pi}{2}$ (that is, from one end to the other of the infinite wire) gives

$$P = \frac{M c}{r}.$$

If the strength of the magnet pole be unity, the force, P, is a direct measure for the strength of the field or velocity of the magnetic stream-lines (induction) in any point, and we find, therefore, the following simple relation for the strength of field surrounding an infinite straight wire:

$$F = \frac{c}{r}.$$

This can be graphically represented by the curve, H (a rectangular hyperbola), the abscissæ, 0 R, of which represent distance, and the ordinates, F, strength of field.

If, instead of employing a single wire, as in Fig. 7, we use a series of wires placed side by side, or a broad strip of conductor, the plane of which is at right angles to the surface of the paper in this diagram, then the field produced by such a current-sheet is independent of the distance, r, provided this distance be small in comparison with the width of the conductor. The strength of the field is given by the formula—

$$F = c,$$

and may be represented graphically by the dotted line H^1 in Fig. 8. In this case the magnetic stream-lines are at right angles to the direction of the current in the broad conductor, and their velocity is sensibly equal (equal induction) at all distances from the surface of the conductor, which are small in comparison with its width. This pro-

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perty of the magnetic field of a broad conductor is made use of in certain current-measuring instruments in central electric light stations. The constancy of the deflecting force on the needle has the advantage that a very even scale may be used.

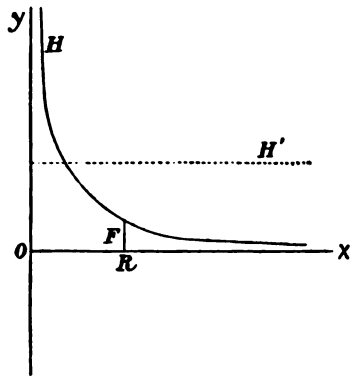

FIG. 8.

By the aid of the formula 1, we can now investigate the magnetic field produced by a circular current. Let, in Fig. 9, W W be a cross section of the wire conveying the current, c, and let a magnet pole be placed at M into the axis of the circle. Since all the elements of the current are at right angles to the line joining them to the pole, sin α is in all cases equal to unity, and the force exerted by an element, l, is

$$P = \frac{M c l}{D^2}.$$

This force acts at an angle to the axis, and tends to displace the pole not only along the axis, but also laterally. The

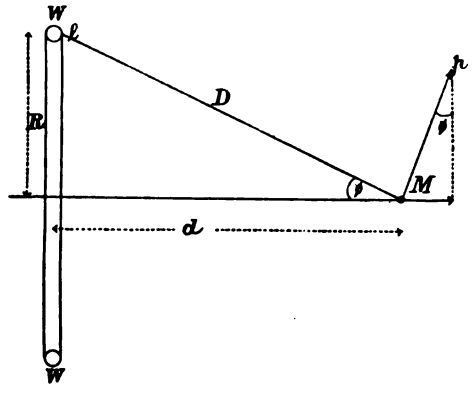

FIG. 9.

lateral component is, however, counterbalanced by the action of the diametrically opposite element, so that only the axial force, P sin ϕ, remains, which for the whole circle is

$$P = \frac{M c 2\pi R}{D^2} \sin \phi.$$

$$P = \frac{M c 2\pi R R}{D^3}.$$

The strength of field is equal to the force exerted upon unit pole.

$$F = \frac{2\pi R c R}{D^3} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$F = \frac{2\pi R c R}{(R^2 + d^2)^{\frac{3}{2}}}, \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where d is the distance of the pole from the plane of the circle. The field of a circular current is frequently used in connection with measuring instruments, and then it is generally desired to obtain the strongest possible field with a given current. By making $d = o$—that is, by putting the indicating needle into the centre of the coil—F becomes a maximum for a given size of coil and given current. The strength of field at the centre is

$$F = \frac{2\pi R c}{R^2} \text{ or } F = \frac{2\pi c}{R} \quad . \quad . \quad . \quad (4)$$

With a given current the strength of field at the centre is inversely proportional to the radius of the coil. It is, however, not always feasible to so arrange the instrument as to bring the needle into the plane of the coil. For constructive reasons the needle must sometimes be placed outside of this plane, and the problem is what radius of coil will with a given current produce the strongest field? This question can be answered by solving the equation:

$$\frac{d F}{d R} = 0,$$

which gives

$$R = \sqrt{2}\, d.$$

The coil will be most effective if its radius be about 41 per cent. greater than the distance of the needle from its centre.

CROMPTON'S SWITCH-BOARDS AT THE WHITEHALL INSTALLATION.

The switch-boards illustrated in Figs. 1 and 2 have been constructed by Messrs. Crompton and Co., of Chelmsford, to the order of Mr. J. E. H. Gordon, for the Whitehall installation, and the figures really indicate two separate parts of one and the same switch-board, made, however, in these separate parts to suit the space available at Whitehall.

The larger board, Fig. 1, is 8ft. 7¾in. high, by 8ft. 1½in. wide, the smaller 5ft. 7½in. by 5ft. 7½in. The fittings in each case are mounted on slate bases, with wrought-iron and brass framings. The larger board may be considered as the positive and the smaller the negative side of the board. Then the general arrangements consist of four sets of leads—the four positive leads at the upper portion of Fig. 1 and the four negative leads at the upper half of Fig. 2. These are the four leads to the mains. There are also four sets of leads from the dynamos (only three sets, however, will be used at first), the positive being connected to the lower half of Fig. 1, and the negative to lower half of Fig. 2. Between the bars, for plugging in the leads and dynamos, are placed eight sets of regulating ring switches, each for twelve regulating cells. Each set consists of two, one charged and one discharged. The ring switch, which consists of discs of stencil copper pressed tightly together on a gun-metal boss, is forced from ring to ring by means of a screw shaft. The 16 shafts can be geared, some, or all, to the horizontal shaft by means of level wheels. This horizontal shaft is worked from either end by a handle. The positive battery terminals being connected to board, Fig. 1, the negative terminals are connected to the eight terminals (one for each battery) on the right of the board, Fig. 2. Each switch has a double cut-out, with a connection to put either cut-out in circuit. Between the cut-outs and lead connections are massive platinoid bars of known resistance to enable accurate measurements of the currents to be made. The ring switches are constructed to carry 300 amperes.

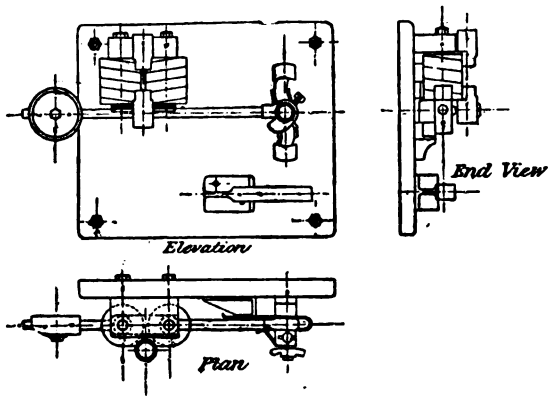

FIG. 3.—Cut-out at Whitehall.

Fig. 3 shows a magnetic cut-out for automatically cutting off the current charging the accumulators. When the cells become fully charged the current is so weakened in the electro-magnet coils that the keeper falls off, and in so doing switches off the charging circuit. The object is to

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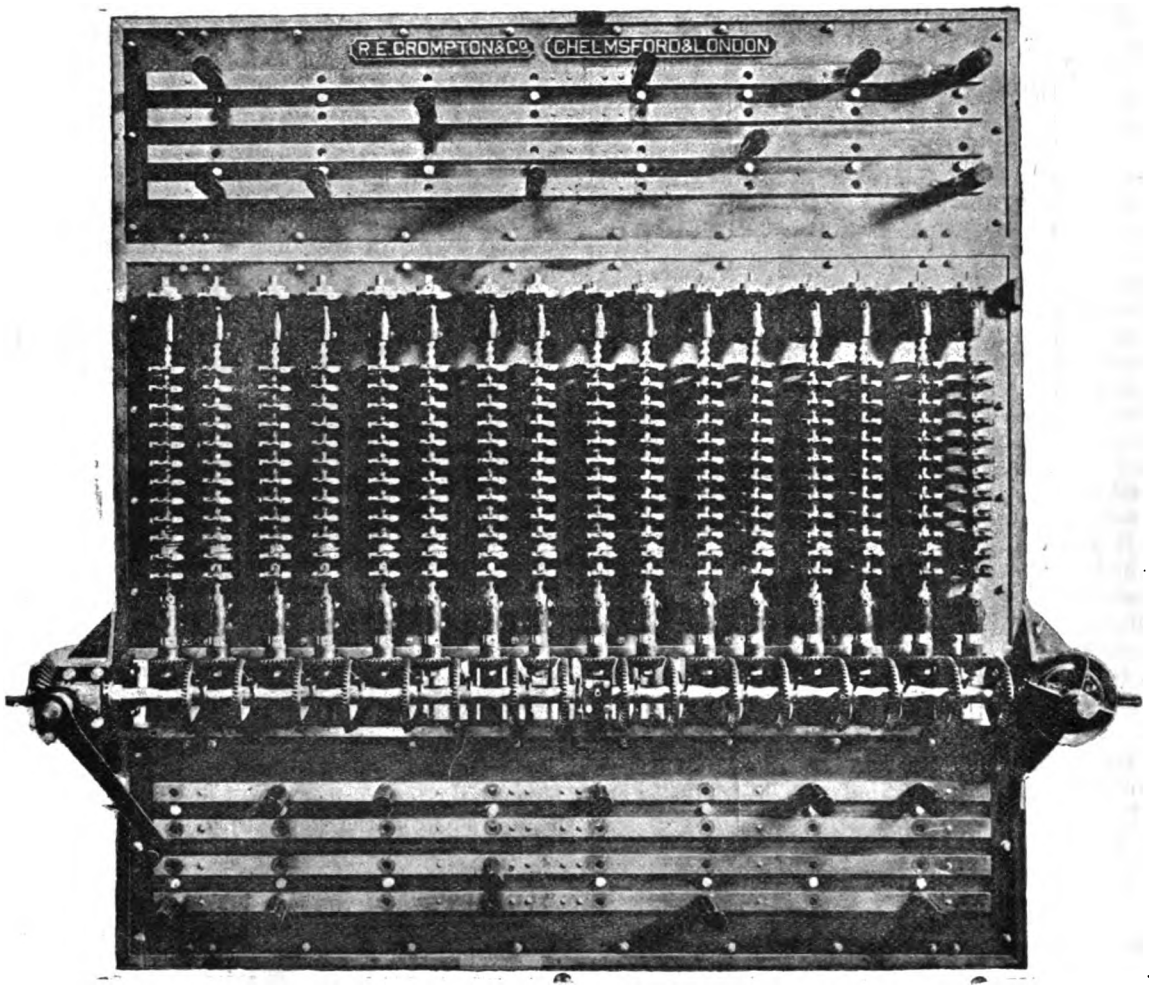
prevent either excessive charging or reversal of the dynamo when the engine is shut down, intentionally or otherwise. The coils are plain spirals of copper, and the cut-out is intended to carry about 1,000 amperes. The bar of the keeper which, in falling, strikes off the switch, is provided with a sliding weight to counteract permanent magnetisation, if any. The shock of the bar falling is taken off by a piece of raw indiarubber in a copper clip.

FIG. 1.—Switchboard at Whitehall.



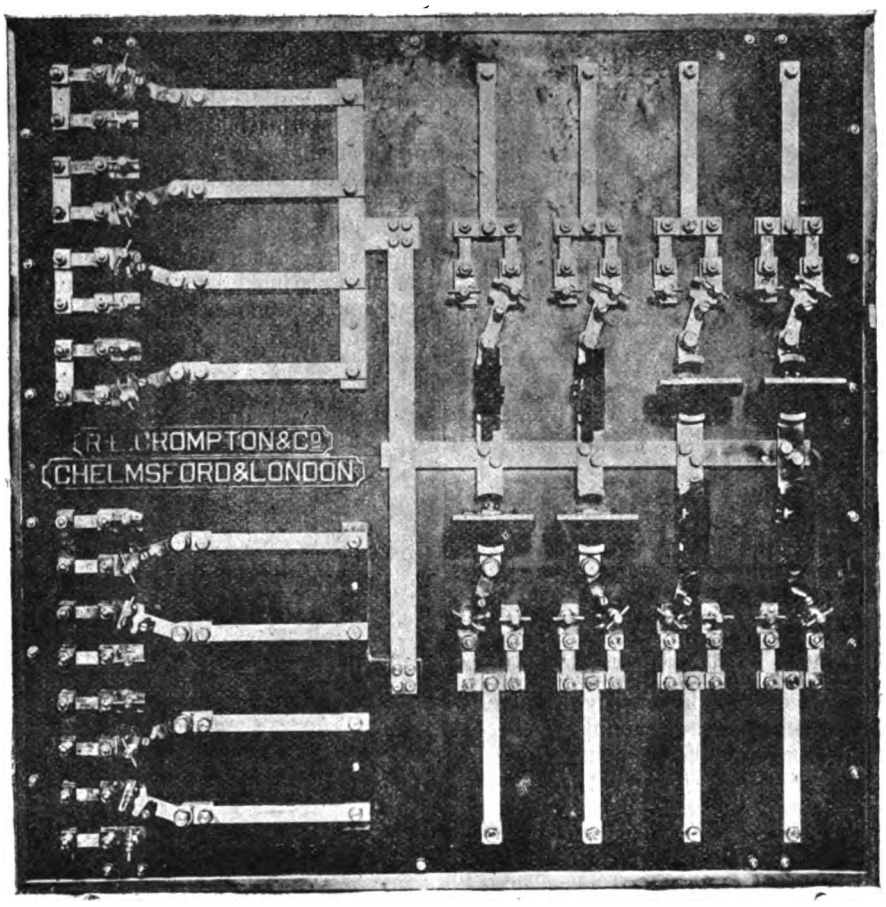


FIG. 2.—Switchboard at Whitehall.

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GLASGOW UNIVERSITY PHYSICAL SOCIETY.

DETERMINATION OF MOLECULAR WEIGHTS.*

BY G. G. HENDERSON, M.A., B.SC.

After dwelling upon the importance of a knowledge of molecular weights, the author explains the methods adopted in determining these weights. He said :

The first methods of determination depend on Avogadro's law that equal volumes of gases at the same temperature and pressure contain equal numbers of molecules. Hence the molecular weights are in the same proportion as the specific gravities of gases. The specific gravity of a gas is referred to the limit H = 1 molecular weights to $H_2 = 2$; hence rule, to get molecular weight of a substance multiply its vapour density by 2.

(*a*) *Dumas' Method*, by which the weight of a known volume of vapour is ascertained by weighing a glass globe of known volume full of the vapour of the substance.

(*b*) *Gay-Lussac's Method*, improved by Hoffman, in which the volume of a known weight of the substance is measured.

(*c*) *V. Meyer's Method*, in which the volume of air is measured, which is expelled from a tube by the conversion of a solid into vapour.

In cases where the substance cannot be converted into vapour or decomposes when heated, the above methods are not applicable. If the material under examination is an acid or base, a salt is prepared and analysed ; but if neither acid nor base it is necessary to study the general chemical properties of the substance, its mode of formation, its reactions and decompositions, and thence arrive at the most probable molecular weight. This naturally is not very satisfactory, but till recently no other means of determination of molecular weights was at the disposal of the chemist. In 1883 Raoult published a paper on "The Law of Freezing of Aqueous Solutions of Organic Bodies," and in 1884 this was followed by another paper on "The General Law of the Solidification of Solvents," ("Ann. Chim. Phys." (5), 28, 133, and (6), 2, 66). In these papers there is described a new method of determining molecular weights, and subsequent experiments have shown that it is of wide application.

The lowering of the freezing point of water, as a result of the solution of various salts, has been the object of various researches. Blagden (1788), and later Rüdorff, proved that the lowering of the freezing point is proportional to the weight of salt dissolved in a constant weight of water. De Coppet in 1871-72 extended these observations, and showed that the "atomic depression" of the freezing point is nearly the same for salts of the same kind and of the same constitution. To get the "atomic depression," multiply the depression of freezing point caused by dissolving 1 gramme of salt in 100 grammes of water by the molecular weight of the salt. Raoult has extended the law to organic substances and to other solvents besides water.

First Paper. Aqueous Solutions.—Raoult examined the solutions of a number of organic substances soluble in water, and representative of the different classes of organic compounds. He observed the amount of depression of the freezing point, and from these observations calculated (1) the "coefficient of depression" for each substance, and (2) its "observed molecular depression." The "coefficients of depression," or depressions corresponding to 1 gramme of substance dissolved in 100 grammes of water, were obtained by dividing the depression found by the weight of substance dissolved in 100 grammes of water.

The "observed molecular depressions" were obtained by multiplying the coefficient of depression of each substance by its molecular weight. As a result of his experiments, he found that the molecular depression of the freezing point is sensibly the same for all organic compounds.

Now, it is possible to calculate the theoretical "molecular depression" of the freezing point caused by any compound, for Raoult proved (1) that the molecular depression of the freezing point for any organic compound is the mean of the atomic depressions of the elements of which it is composed, and (2) that the "atomic depression" of each element is the same in all organic compounds—*e.g.*, it is 15 for C and H, and 30 for O and N.

Hence, to find molecular depression, T, of any compound, $C_pH_qN_rO_s$.,

$$T = \frac{p \times 15 + q \times 15 + r \times 30 + s \times 30}{p + q + r + s}.$$

This gives us the rule for finding the molecular weight of any compound.

The simplest atomic formula of the substance is found by analysis, and the molecular depression, T, corresponding to this is calculated in the manner just described. The coefficient of depression, A, is found by experiment. Then, if M = molecular weight,

$$M = \frac{T}{A}.$$

For example, we find by analysis that oxalic acid must have one of the formulæ—CHO_2, molecular weight 45 ; $C_2H_2O_4$, molecular weight 90 ; $C_3H_3O_6$, molecular weight 135 ; &c. Calculating the molecular depression, we get

$$\frac{T = 1 \times 15 + 1 \times 15 + 2 \times 30}{1 + 1 + 2} = \frac{15 + 15 + 60}{4} = 22{\cdot}5,$$

experiment showed the coefficient of depression to be 0·255°.

Hence $$M = \frac{22{\cdot}5}{0{\cdot}255} = 88 \quad (C_2\,H_2\,O_4 = 90).$$

Therefore, the true formula of oxalic acid is $C_2\,H_2\,O_4$. As the molecular depression, T, of the freezing point of aqueous solutions of organic substances is never far from 18·5, we may take in all cases without much error

$$M = \frac{18{\cdot}5}{A},$$

and thence we get the rule: that is the true molecular weight of a substance, which, when multiplied by the coefficient of depression of the freezing point of an aqueous solution of that substance, gives the product most nearly approaching 18·5.

Second Paper.—In this Raoult examines various other solvents in the same way as he treated water ; of these I shall mention only acetic acid and benzene, as being the most important.

The depression of the freezing point, caused by the presence of a foreign substance in a solvent is obtained by taking the difference between the freezing point of the solution and that of the pure solvent, determined in the same way.

If P = weight of solvent, P^1 = weight of substance dissolved, K = the depression of the freezing point found by experiment, A = "coefficient of depression" (*i.e.*, depression which would be caused by 1 gramme of substance in 100 grammes of solvent), Raoult found that $A = K\left(\frac{P}{P^1 \times 100}\right)$. All the solutions examined, when sufficiently diluted, obeyed the law of Blagden—or at least very closely.

As a result of his experiments with acetic acid, Raoult found that the molecular depressions produced by different compounds in acetic acid, all approximate to two numbers —39 and 18—of which the first, which occurs in the immense majority of cases, is sensibly double of the other.

Similarly, for benzene, he found that the value of the molecular depression of the freezing point is, for most substances, equal to 49 ; for a few, to 25.

The same law is found to hold good for water, the values being 37 and 18·5.

Conclusions.

1. Every substance—solid, liquid, or gaseous—in dissolving in a definite liquid compound capable of solidifying depresses the freezing point of that liquid. This rule is absolutely general, so far as experiment has shown.

2. There is for each solvent a *maximum* molecular depression of the freezing point—*e.g.*, 47 for water, 39 for acetic acid, 49 for benzene.

3. In all solvents, the molecular depressions of the freezing point, caused by different compounds dissolved in them, all approach one of two mean values, variable

* Abstract of paper read at the meeting, October 26.

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according to the nature of the solvent, and of which one is double of the other.

By means of this law, knowing the mean molecular depression for any solvents, we can determine the molecular weight of a substance dissolved in it. Thus, all organic substances when dissolved in acetic acid produce a molecular depression of about 39; the formula which must be adopted for an organic compound substance in this liquid is that which corresponds to that molecular weight which most nearly approaches the number obtained by dividing 39 by the coefficient of depression of this substance in acetic acid.

These rules may be explained by admitting that in a constant weight of a fixed solvent, all physical molecules, whatever their nature be, produce the same depression of the freezing point.

To demonstrate this, it is necessary to calculate the results for the case where 1 molecule of each substance is dissolved in 100 molecules of solvent. This is done by dividing the molecular depression (= T) of each body by the molecular weight (= M^1) of the solvent. The molecular depressions are those caused by 1 molecule of a foreign body in 100 grammes, or $\frac{100}{M^1}$ molecules of solvent. On the other hand, the depressions, according to Blagden's law are, other things being equal, inversely as the quantities of solvent which contain 1 molecule in solution. Let T^1 then = the depression produced by 1 molecule dissolved in 100 molecules.

$$T \times \frac{100}{M^1} = T^1 \times 100,$$

whence

$$T^1 = \frac{T}{M^1}.$$

Applying this formula to the number T and M^1 experimentally found, it appears that T^1 varies only from 0·59° to 0·65°, mean 0·63°, for all solvents, water alone excepted (where $T^1 = 2·61$). The anomalous behaviour of water is capable of explanation, in supposing that the molecules of water are united in fours, $T^1 = \frac{2·61}{4} = 0·6$

General Law of Freezing of Solvents.—If 1 molecule of any substance is dissolved in 100 molecules of any liquid of different nature the freezing point of that liquid is lowered by an amount which is always almost the same and near to 0·63°.

Consequently the depression of the freezing point of a dilute solution of any nature is sensibly equal to the product obtained by multiplying 63 by the proportion which exists between the number of dissolved molecules and that of solvent molecules.

Raoult's new method of determining molecular weights is one which needs no costly or complicated apparatus, and only the ordinary precautions necessary in taking observations to a fraction of a degree C. The great importance of the discovery lies in the fact that it is applicable to many, if not all, of these cases where it is impossible to make a vapour density determination, and by its help we shall be able to ascertain the true molecular weight of many substances to which hitherto it has only been possible to assign a probable molecular weight in an indirect way. Thus, for example, Brown and Morris have applied the method to ascertain the true molecular weights (and hence formulæ) of some carbohydrates, dextrose, cane-sugar, maltose, &c. Ramsay has proved that the formula for liquid nitric peroxide is N_2O_4, Beckmann is investigating the molecular weights of the oximes, &c., &c.

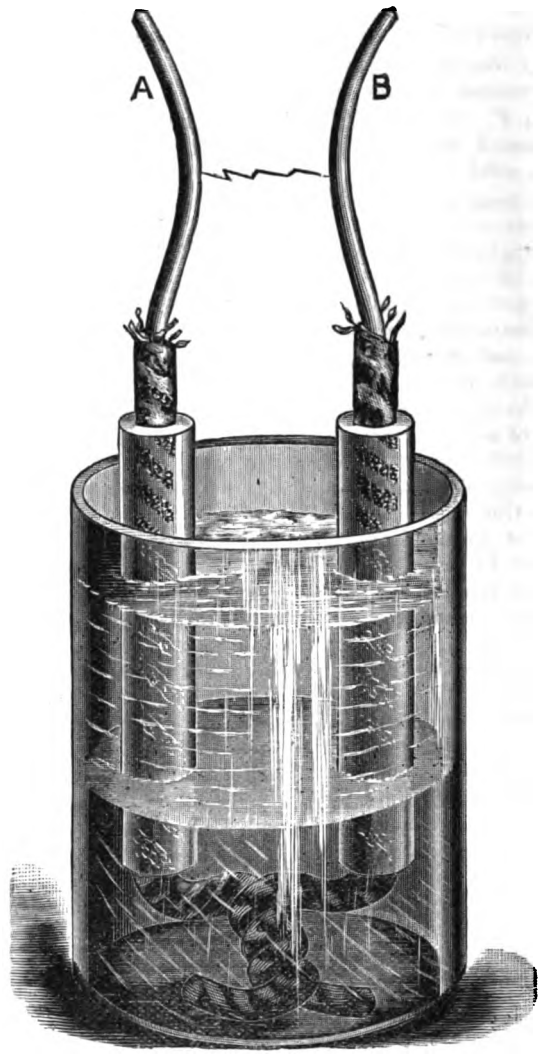
Strangely enough, Raoult's brilliant investigations have till recently received little attention from chemists, though perhaps they are the most important contribution to the supply of physical methods applicable to chemical research since Dulong and Petit published their well-known law.

PASSED THE INSPECTOR.—A wonderful story was going the rounds at the Electro-Harmonics the other night of some cable it was thought might actually satisfy the never-to-be-satisfied inspector. It was only $\frac{7}{16}$ cable, but so thickly insulated that it couldn't be got in the door, and therefore had to be run outside.

INSULATION.

Mr. David Brooks writes to us from Philadelphia as follows:

At the National Electric Light Association, held in New York some six weeks since, Mr. Acheson read a paper on "The Determination and the Cause and Cure of the Frequent Puncturing of the Insulation, especially at the Terminals of Lead-encased Conductors when carrying High-Potential Currents." As this paper of Mr. Acheson's has had a pretty extensive publication in the electrical journals, I offer a few remarks on the "determination of, and the cause and cure," &c. He speaks of the trouble as "disruptive discharges." In coiling and uncoiling lead you are liable to open pores. As lead tubing is coiled, the outer surface of the tube forming the circle is elongated and the inner surface compressed; and this condition is



produced by the comparatively rigid nature of the cable or conductors inside. If the insulation consists of paraffin which is all broken by the coiling and uncoiling, and a "pinhole" happens to be open to the paraffin, moisture penetrates the lead and paraffin also, and gets to the conductor. If, instead of paraffin, a mixture of resin and resin oil is used, and moisture gets to the mixture, it stops there, because the moisture is semi-liquid and heavier than water; but as lead tubing is drawn over the cable it comes in contact with its textile covering inside. Now if moisture reaches the textile covering, the covering will absorb it; and it makes no difference whether you use paraffin, asphalte, resin and resin oil, or any similar substance.

There is no way of making any vegetable fibre moisture-proof except by surrounding it by some substance that is itself moisture proof. If we take a piece of lead-encased cable, make a hole no larger than the point of a needle, and immerse that portion in water, if the hole goes no farther than to reach the paraffin, it will go to the conductor, and the insulation is impaired. Similarly, if the insulation consists of resin and resin oil, the moisture will reach the

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mixture, but goes no farther—the insulation is not impaired; but if the pore is open to the textile covering, which is liable to be in direct contact with the lead, the textile covering will absorb the moisture, and insulation is impaired. I have shown this experiment many times.

There have been many attempts made to lay lead-encased cables across rivers, and every one, to my knowledge, have proved failures where the insulation consisted of paraffin, although the lead was served with hemp saturated with tar, and further protected with an armour of iron wire; but when resin and resin oil were used, and the lead served with a similar outside sheathing, better results were obtained. These cables were used for telephone purposes where feeble currents are employed. How much more liable are these cables to fail when currents of a high potential are used? How many lead-encased cables have failed in this country when used for telephone purposes? Can it be said that they were destroyed by disruptive discharges when they were provided with lightning protectors, point dischargers, and plate dischargers?

With this I will explain an experiment. A glass jar is about one-third filled with a mixture of resin and resin oil, two cotton-covered wires are twisted together, and the ends separated as shown in the bottom of the jar, the wires are heated in the mixture to 350deg. F. before being immersed, then two glass tubes are drawn over the wires, the tubes extending into the mixture below. We then turn water on to the mixture, filling a portion of the jar, as shown in the figure. The wires are supposed to be a No. 16 gauge, insulated to one-eighth of an inch diameter, although the wires are separated from each other at the point when twisted to less than one-eighth of an inch. If we apply the two poles of a Holtz machine at the ends A and B, we can pass a spark from the bare portions of the wire two inches in length before the current can be made to pass through the covering of the wires when twisted together. It will be seen how easy it is to protect the insulation from disruptive discharges. Iron pipe is a thorough and radical "cure," or rather preventive of "pinholes." If we substitute paraffin in place of resin and resin oil mixture, the water penetrates the paraffin; although it has been allowed to cool and become seemingly solid, the insulation between the wires fails.

The cable that I laid for the Pennsylvania Railroad Company over a year since embodies these principles; it contains fifty-three conductors. On May 5th Prof. Kendal gave the average insulation over 4,000 megohms per mile. Every conductor is in perfect condition. The professor will make another test of the conductors soon, and I will send you the results.

CHELSEA ELECTRIC LIGHTING.

The following circular has been issued to the residents in the Chelsea district by the Chelsea Electricity Supply Company:

The Directors of the Chelsea Electricity Supply Company, Limited, beg to announce that, in consequence of the amendment in the Electric Lighting Act of 1882, by which the term of their provisional order (known as Electric Lighting Order Confirmation Act, 1886, 50 Vic., chap. 18), has been extended from twenty-one to forty-two years, the time has arrived when they can with confidence invest the necessary capital (namely, £32,000), under the terms of their Act, in the erection and maintenance of electric lines and works, and in the supply of electricity within the district described in the Act as "District A" in the parish of Chelsea.

The company has made contracts for laying underground the necessary distributing mains, and work under these contracts is in progress. It is not their intention to resort to any temporary expedient or makeshift system, involving the use of cables carried overhead, which they regard as fruitful of danger to the public and a disfigurement to the neighbourhood, besides being sure, before long, to cause breakdowns and defects in the service. They consider that many other reasons, such as injury to roofs, and risk to property and persons through lightning discharges, justify the discouragement of any increase in the use of overhead conductors.

The company has also made contracts for the erection of its central station, and for subsidiary stations for the storage of electricity.

Subject to the fulfilment of the conditions of the Act and of the rules and regulations prescribed by the Board of Trade, there will be no delay in commencing the supply, and the residents may feel assured that the company will be unremitting in its endeavours to complete and be ready to supply electricity in the shortest possible time, compatible with good and efficient construction.

The company has also taken the necessary steps under their Act to entitle them to proceed with similar works in other parts of the parish besides the district described in their Act as schedule A.

They beg again to remind the residents that they are the only company at present in possession of an Act for electric lighting, and that their foresight in obtaining it in 1886 now enables them to go to work twelve months in advance of any other undertakers in any other parish of London, under conditions which should entitle them to the support of the public, whose interests and safety are secured under its terms.

The company relies on the residents of Chelsea helping forward the undertaking which Parliament has sanctioned and put under official control, and trusts that they will not encourage desultory and indiscriminate competition, which can only result in unsatisfactory service.

It should be understood that the public is guarded against any monopoly by the terms of the Electric Lighting Act, which, for that purpose, has vested all necessary powers in the Board of Trade.

The Chelsea Electricity Supply Company, Limited, in placing these facts before their future customers, believe that the postponement of operations under their Act until the present time are now fully explained, and that the wisdom of this delay will be confirmed by public opinion. The company has now taken vigorous action to make up for the loss of time caused by the defect in the legislation of 1882, which was rectified in the session of Parliament just concluded.

The company will work through small stations located for the distribution of electricity to the houses immediately around them. In these stations the process of storing electricity by charging from a central station will always be going on. By this arrangement the advantage of perfect steadiness of light is secured, and a large reserve maintained, so that the well-known risks inherent to what is known as the "transformer" system are totally avoided.

One important objection to that system—namely, that conductors conveying high-tension currents dangerous to life enter the premises of each consumer—is avoided.

The accumulators being placed in stations belonging to the company, and not in customers' houses, will be under one control and constant supervision, and customers will have no responsibility whatever for their custody or accommodation, and will not suffer from the inconvenience of having them in premises not adapted for their reception.

The company desires that the cost of the light to their customers should be thoroughly understood. The public have been told by some that the current will be supplied for 7d., and by others for 6d. per Board of Trade unit; but have they been told whether this price is for the current before or after its entry into the secondary generators to be installed in the houses, whether such be in the form of accumulators or transformers? This is an important condition, as in the former case the loss of efficiency caused by passing through the apparatus is charged to the consumer, and the actual price is, therefore, above the nominal 6d. or 7d.

The maximum price chargeable by the Chelsea Electricity Supply Company under its Act is 10d. per unit, but the company has decided to charge at first at the rate of 8d., by meters approved by the Board of Trade, for the actual current consumed in the customer's house. This is estimated to cost the consumer almost exactly ½d. an hour for each glow lamp, yielding ten candles. Gas burners using 5ft. of gas an hour cost nearly seven-tenths of a farthing per hour at the present price in this district. Residents are reminded that this comparison of cost cannot affect the fact that electric light can be used in living-rooms, where gas should never be admitted, and that the facility of turning lights in and out as required produces a very real economy of light, to say nothing of the saving from the sanitary point of view, and in the absence of all the bad effects which gas has on ceilings and decorations.

The Chelsea Electricity Supply Company considers that its interests are bound up with those of its future customers, in securing that the installation of wires in buildings shall be efficiently and economically carried out.

With this in view they are prepared, if desired, to act as follows: 1. To prepare an accurate specification and description of the work required, which will ensure a correct estimate of cost being arrived at before the work is entered upon; that the rules of the fire insurance companies are not violated and the insurance voided; and that all the wants of the future owners are carefully provided for, and alterations and unforeseen expense prevented. 2. To supervise the work during execution; and 3. To certify the same (for payment) on satisfactory completion of the work.

For these services they will only charge a nominal fee, varying with the quantity of the work in each installation.

COMPANIES' MEETINGS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY.

The annual meeting of the Edison and Swan United Electric Light Company, Limited, was held on Tuesday at the Cannon-street Hotel, the Chairman (Mr. James Staats Forbes) presiding.

The **Secretary** (Major S. Flood Page) read the notice convening the meeting, and the report of the Directors was taken as read.

The **Chairman** said he would first refer to the figures of the balance-sheet, and the profit and loss account, dealing first with the debit side of the former, which left, as far as substantials were concerned, no change whatever. The subscribed capital was exactly as it had been; but there had been an alteration in the method of stating it in the account, and there was a printer's error—a reference to "5,000 A shares of £5 each, fully paid, allotted to the Edison and Swan United Electric Light Company." It should have said there were 5,000 shares—all being fully paid—allotted to the Edison Company. This was a part of the purchase of the Edison concern; and the next entry, of 12,139 A shares of £5 each, fully paid, allotted to the Swan United Electric

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Company, was part of the purchase of the Swan concern. There were sundry credit balances, and what they owed their creditors was £10,214. 2s. 7d., as compared with £5,799. 6s. 2d. last year, so that they were in debt a little more; but they need not be alarmed about that, because the volume of their business on the year had been considerably greater than in the preceding year. And when they came to the other side of the balance-sheet, they would find that, whereas they were somewhat more in debt, they had a much larger amount of good debts due to them. The profit and loss account for the year showed a credit balance of £25,123. 9s. 7d., against £16,221 in the preceding year. On the other side of the account, the cost of patents, goodwill, preliminary outlay, loss on working, as per last balance-sheet, was £300,814. 2s. 9d. Further expenditure thereon—£3,213. 18s. 8d.—brought that amount up to £304,028; but they had been enabled during the year to get rid of some bad bargains which came over to them in the union of the two companies, by the sale of some plant to the extent of £12,790, which, of course, was a credit item in the shape of diminution. Then there was another item embraced by the general description three hundred odd thousand pounds loss on working. Honourable proprietors would remember that in the earlier years of their work, instead of showing a sheet of losses, they determined that those losses of the earlier years must be redeemed out of the profits of later years until they disappeared. Happily, now they had disappeared, through diminishing the item from year to year by the profits made, and there was £25,000 profit in the present balance-sheet, free of all claim of that kind. They were on their legs, therefore, as a money-earning concern. Alluding to the stock, the Chairman said: That induces me to call your attention to the fact that the stock brought forward last year on July 1 was only £12,868 in value, whereas the stock carried forward in the current year was £19,590, and that, you will see, bears some proportion to the increased business done; and it arises from what I explained, I think pretty fully, last year, that this business cannot be carried on without a very large reserve of manufactured lamps in stock. A great number of varieties of lamps, to suit the wants of different purchasers, must always be on hand; therefore you must end the year with a considerable number in stock to meet demands that may come upon you from day to day. If the sale of lamps in the year had remained stationary, while the stock carried forward had increased greatly, it would have been an ill sign; but as it really bears about the same proportion to the stock carried forward last year that the increased volume of business bears to the business of last year, I think it is about the right proportion; and the lamps, I need hardly tell you, are put down at approximately cost price. Now, gentlemen, that is the whole story of the accounts, and that is all the story I shall have to tell upon matters of account, for I wish to come to the question of this balance of £25,123. Supposing we were absolutely free of all legal questions, there is no doubt whatever that on the working of our business for the year we have honestly earned a profit of £25,000, after charging the concern with every proper outlay, and being somewhat liberal in the case of ordinary depreciation of plant, and so forth. But, having left you there, I will now go to the report, because I have exhausted paragraph 2 by dealing with the accounts. That paragraph is very brief. It says: "The sale of lamps has progressed in a satisfactory manner during the year. The volume of the Company's business has increased, and has resulted in a credit balance of £25,123. 9s. 7d." This time last year we were living in the belief that our patents were not only decided on appeal in the action of Woodhouse and Rawson, but were invulnerable. Well, since then our little illusion has been somewhat disturbed by the fact of an action brought by the Brush Company, in which the whole question of these patents had to be retried. Well, it is an illustration of the law of patents, that whilst Justice Kay's decision upon the Cheesbrough patent formed the decision already given in the Woodhouse and Rawson suit, his opinion of the Edison patent was different to that of the courts, both of first instance and appeal, upon the Edison, and that it is declared to be invalid. Well, there it is; the Cheesbrough is declared again to be a valid patent, whilst the Edison patent is declared to be invalid. That is the decision of Justice Kay. Well, our learned friends, the great technical lawyers, whose minds are impregnated with all the history of this matter, and our technical advisers, tell us that Justice Kay is very wrong. Of course, on that opinion we are going to appeal, and I am not going to predict what the result of an appeal may be. I can only tell you what competent experts tell us—that there is every probability that Justice Kay's decision on that point will be reversed. Well, I hope it will, although I am bound to say I do not think it a matter of primary importance that it should be, seeing that the Cheesbrough patent has been confirmed. We shall soon know, because I suppose that matter is coming on within a month. I see we promise the appeal shall be settled before Christmas, and if it is settled in our favour, I daresay we shall eat our Christmas dinner with a little more hilarity than if it is not; but whether it is or no, it will not, I fancy, have anything like a disastrous effect upon the future of this Company. Well, then, the American Brush Company brought actions on two subjects. Very little importance attached to the first one, and as to the second—well, in matters of patents, who can tell? Anybody who wants to know the enormous dangers which are inherent in patents can read the proceedings of these two actions. I do not know how it may come out, but we are bound, if people bring actions, to defend them, and our legal advisers tell us we need not be in a state of alarm. I suppose these actions will proceed. Now we are face to face with a profit legitimately made on the operations of the year, but with indefinite liabilities as to costs, in consequence of these actions. Well, I don't want to alarm anybody, because I don't think myself, as a matter of personal opinion, there is much ground for alarm; but what I should like to impress upon the shareholders is this—the great imprudence and unwisdom of parting with the profits of the year until questions so vital have been settled; because you will see at once—although the legitimate consequence of a decision against us, or the Edison, on appeal might, in our going concern, not be of great importance as lamp-makers—the question of costs would be serious. Instead of having costs to receive we should have costs to pay, and I can tell you that costs to pay, in reference to patent actions, is about the most serious thing that you can face. I know a good deal about costs in different kinds of proceedings at law—parliamentary amongst others—which are bad enough; but costs in patent actions are something awful. There may be a claim for damages. Well, our opponents are exceedingly ingenious people, and not more scrupulous, I suppose, than other people, and if their ingenuity cannot only get the costs of the proceeding, but can land us in damages, I think it would be most unfortunate that we should have parted with the profit of the year pending such questions. We have considered this with very great care, with the assistance of our legal friends and shall recommend the shareholders to carry that £25,000 forward on to reserve, and not to distribute it. Then we come to No. 7 paragraph: "Lord Thurlow's amendment of the Electric Lighting Act of 1883 is leading to a considerable development of electric lighting, and to a corresponding increase in the Company's business." Well, of course, we have reduced our early aspirations to the humble *role* of lamp-makers, and lamps cannot be burned without installations, and we are very delighted to see other people embarking their capital and energy in the installing work; and, of course, it is very gratifying to us that the legislation of 1882, which was very disastrous in its results, by handicapping electric installations, should have been so far modified that an immediate stir in the development of electric lighting has followed the alteration of the Act. The Chairman explained the change made, by which the period at the end of which authorities may resume the privilege of supplying the electric light, after conceding it to a company, is extended from 21 to 42 years, and pointed out that there was also an important modification in the terms upon which machinery would be taken over in that event. He said there was no doubt the amendment of the law would give an immediate impetus to the progress of this business. He noticed there had been an extraordinary installation going on at Deptford in connection with the London Electric Supply. He knew most of the people in it, knew there was plenty of money in it, and that there was some ability in it, and he saw that amongst other things predicted of it was that between now and the winter of next year they would want 250,000 electric lamps. We know where they can get them. So do they, because they are some of our best customers; and that is one indication. I dare say that the prediction of 250,000 for that one company may be a little exaggerated; but it may be all taken as evidence of what I have said, that this electric lighting business is going on, and if we can maintain our patent, as we certainly can—but most of all, if we can maintain the character we have got of making the best practical lamp there is in the market, then, I think, we are very likely to participate, at all events, largely in this great progression. And, fortunately for us, our capital need not be enlarged, or materially enlarged, to enable us to meet the claims of the additional manufacture of these lamps. Now I think I have said nearly all I ought to say. The words of the report formed a text, and I have preached upon it, and I will now move the resolution, "That the report and accounts be received and adopted."

Mr. Frederick Richard Loyland (deputy-chairman) seconded, agreeing that it would be wise not to divide the balance until the questions were settled between the Brush Company and this one.

The **Chairman**, in reply to **Mr. Donovan**, said this Company held a certain number of the deferred shares of the Manchester Company, and stood in the same position to them as that of the Edison towards this Company. He would take it that the Directors were authorised to carry forward the balance.

With this understanding the resolution was carried unanimously.

Mr. Forbes having vacated the chair, was re-elected a director on the motion of **Mr. Loyland**, seconded by **Viscount Anson**, and (Mr. Forbes again presiding) Mr. Loyland was re-elected to the Board, on the proposition of **Mr. Crompton**, seconded by **Mr. Roberts**.

The Auditors (Messrs. Quilter, Welton, and Co.) were reappointed, on the motion of **Mr. Gay**, seconded by **Mr. Letts**.

The meeting concluded with a vote of thanks to the Chairman, which was moved by **Mr. Gay**.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.

The sixteenth ordinary general meeting of this Company was held on Thursday, October 25th, at Winchester House, Old Broad-street.

Mr. W. S. Andrews, who presided, congratulated the shareholders on the continued increase in the revenue of the Company. The half year under review (to the 30th of June) was the "lean" half, and the total earnings in that period had been £86,874, or an increase of £5,454 over those of the corresponding period of 1887. In the current half-year, he was glad to say, the improvement had been still more marked, the earnings, so far, having exceeded those of the corresponding period of last year by about £25,000. There were still two months and a half to run, and, in the absence of any misfortune—of which they could see no sign at present—they had no reason to think that the outcome of the year's working would be other than very satisfactory. The expenditure in the half-year to June had been less, but that was mainly owing to the diminution in the expenditure on renewals of cables. After giving the details of the expenditure under different headings, he stated that the final result was a net revenue of £54,061, which was increased by the amount brought forward to £57,525. After paying debenture interest, and putting aside £7,500 to renewal fund and £6,000 to the fund for the redemption of debentures, they had a balance of £30,525 left, out of which they recom-

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mended a dividend for the half-year at the rate of 4 per cent. per annum, as compared with 2½ per cent. per annum for the corresponding period of last year. The balance carried forward would be £3,290. The accounts did not include the contribution which they would receive from the Platino Company, whose accounts had generally been published somewhat later than their own. In all probability, the Directors of the Platino Company would declare their usual interim dividend at the rate of 2½ per cent. per annum, and, if so, the Western and Brazilian Company would receive between £3,000 and £4,000, which would go to the credit of the current half-year. The Directors intended in the future to accelerate the Platino accounts. At their last meeting they discussed the questions of debenture redemption and loops, and the outcome of this year's working would probably enable them to somewhat expedite the settlement of those questions. The exchange of shares with the Platino Company was going on very successfully. In 1882 there were 688 shareholders in the Western and Brazilian Company, and there were now 1,365. He concluded by moving the adoption of the report, and the payment of the dividend recommended.

Mr. H. Weaver seconded the motion.

A short discussion followed, and, in reply,

The **Chairman** stated that the payment made by the Company of £8,000 to the Directors and employés of the Platino Company, in connection with the arrangement which had been entered into with that company, would be recouped by the Directors of the Western Company having undertaken to perform the labours of the Platino Company. The arrangement was beneficial to both companies. They had no intention of electing an additional Director. The suggestion as to appointing a second auditor could be discussed at the next meeting.

The motion was then adopted, and the meeting terminated.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

The thirtieth ordinary general meeting of the Brazilian Submarine Telegraph Company, Limited, was held on Wednesday at Winchester House, Old Broad-street, Viscount Monck, chairman of the board of directors, presiding.

The **Chairman**, in moving the adoption of the report, said that amongst the various duties of this kind which he had to perform, there was none which gave him more satisfaction than meeting the shareholders of this Company. He had now been the chairman of this Company for fourteen years, during which time the Board had been able to manage the undertaking to the satisfaction of the proprietors. He hoped the nature of the present report would also meet with their approval, and that it was such as to preclude any necessity for argument. Since the last meeting they had had a good deal of repairs over the Lisbon St. Vincent section. There were faults, which, however, had been now removed, and the cable now tested as satisfactorily as when it was first laid down. They had been under the impression that there was a second fault near Lisbon, but fortunately it was discovered in the neighbourhood of Madeira, and being able to localise it, the repairs were executed, and the cables were now in perfect condition. The cost of these repairs had very largely increased the expenses of the half-year, the amount being £7,908. With this exception, the expenditure was very much what it was last year. The expenditure at the stations, &c., had increased some £793 on the corresponding half of last year, which included increase of salaries to clerks, travelling expenses, &c., though the general expenses in London showed a decrease of £157. The income showed a growing increase, being £7,000 in advance of the previous half-year, and £8,000 or £9,000 in advance of the corresponding half of the previous year. The receipts since the end of the half-year under consideration showed an equal, if not a larger, increase. With the bonus, the Directors were able to recommend the usual dividend of 7 per cent. per annum, and to set aside £30,000 to the reserve fund, which now amounted to £170,000. They had also paid off a considerable sum of debentures, money raised for the purpose of duplicating the cables, and he hoped that in a short time they would be able to announce that this duplicated cable had been entirely paid for out of revenue. With regard to the African Direct Cable, their interest in it was taken more as a defence to their system than as a speculation; but he hoped that it would eventually prove a source of gain to them. As to their position in Brazil, the Board had been endeavouring to strengthen it; but, although they hoped to carry out the negotiations with success, they were still pending, and he asked them to prolong their confidence in the Directors, and not be too inquisitive on the subject on this occasion. He concluded by moving the dividend resolution.

Sir James Anderson seconded the motion, which was carried unanimously.

Sir Thomas Fairbairn and Mr. Henry Daniel Gooch were reappointed Directors, and the meeting terminated.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the past week amounted to £5,151.

Edison and Swan Electric Company.—For the year ended June last the accounts of the Edison and Swan Electric Company, Limited, show a balance to credit of profit and loss of £25,123.

Western and Brazilian Telegraph Company.—The traffic receipts for the week ending October 26, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £4,289.

NEW COMPANIES REGISTERED.

Automatic Electric Supply Company, Limited.—Registered by W. G. Hannay, 28, Duke-street, W., with a capital of £25,000 in shares of £1 each. Object: to manufacture and deal in automatic delivery boxes, electrical or otherwise, machinery, appliances, &c. The first subscribers are:

	Shares.
W. G. Hannay, 18, Duke-street W.	1
G. E. Way, 18, Gascony-avenue, N.W.	1
H. Levites, 13, Hansy-street, W.	1
J. Golding, 162, Major-road, Stratford	1
S. J. P. Allen, 49, Endymion-road, Finsbury Park	1
A. Serraillier, 29, Meek-street, West Brompton	1
E. D. Sale, 1, Nelson-street, Greenwich	1

The Company is registered without articles of association, and consequently the regulations of the Companies' Act, 1862, will apply.

The South African Lighting Association, Limited.—Registered by Wilkins, Blyth and Dutton, 112, Gresham House, E.C., with a capital of £50,000 in £10 shares. Object: to supply gas, electric, or any other artificial light within Port Elizabeth and King William Town, and elsewhere in South Africa, or any islands or countries near thereto. The first subscribers are:

	Shares.
W. Cash, 90, Cannon-street, E.C.	1
E. K. Blyth, 112, Gresham House, E.C.	1
A. L. Don, Hillside, Stonebridge, N.W.	1
D. F. Goddard, St. Margaret's House, Ipswich	1
S. Cutler, 11, Vanbrugh-park, Blackheath, S.E.	1
C. Woodhall, Palace-chambers, Westminster	1
J. Cloudsley, Stonebridge-park, Willesden, N.W.	1

There shall not be less than three nor more than seven Directors of the Company. The first Directors shall be L. Ford Goddard, James Mansergh, and William Woodhall, M.P. The qualification of a Director shall be the holding in his own right of at least 50 shares in the capital of the Company. The Company in general meeting shall determine the remuneration to be paid to the Directors for their services.

PROVISIONAL PATENTS, 1888.

OCTOBER 19.

15,017. **An improved electrical indicator to show from which room or station a bell has been rung in domestic electric bell and telephone circuits.** Frank Kendall, High-street, Towcester, Northamptonshire.

15,030. **Improvements in combined steam engines and dynamo-electric machines.** John Gwynne and Charles Friend Cooper, 46, Lincoln's-inn-fields, London, W.C.

OCTOBER 20.

15,104. **Improvements in electric meters.** Thomas Alexander Garrett and William Lucas, 10, Caledonia-street, King's Cross, London.

15,105. **Improvements in fire alarm telegraphs.** Henry Frederick William Lewis, Henry Alfred Charles Saunders, and Alfred Charles Brown, Winchester House, Old Broad-street, London, E.C.

OCTOBER 22.

15,183. **Improvements in electrical telegraphs.** Edmund Edwards, 35, Southampton-buildings, Chancery-lane, London. (Eduard Cassalette and David Kunhardt, Germany.) (Complete specification.)

OCTOBER 23.

15,206. **Improvements in apparatus for transmitting telegraphic indicating or other analogous signals or movements.** Andrew Betts Brown, 87, St. Vincent-street, Glasgow.

15,216. **Improvements in the construction of switches for the making and breaking of circuits conveying electric currents.** Charles Mark Dorman and Reginald Arthur Smith, 24, Brasenose-street, Manchester.

15,237. **An improved process for the manufacture of alkaline metals, such as aluminium, chromium, &c., by electrolysis and chemical reactions, and apparatus therefor.** Matthew William Walback Mackie, Turk's Head Yard, Turnmill-street, London, E.C.

15,249. **Improvements in dynamo electrical machines.** Sebastian Ziani De Ferranti, 24, Southampton-buildings, London, W.C.

OCTOBER 24.

15,324. **Improvements in the means for establishing electrical communication in railway trains.** James Charles Margetson, 169, Fleet-street, London.

OCTOBER 25.

15,356. **Improvements in or applicable to the coating and varnishing machines used in the manufacture of oil-cloth, and in calendars and other machines used in analogous processes, to prevent the same becoming electrically charged and thus dangerous to combustible materials by giving off sparks.** John Hull, 8, Quality court, London.

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15,369. **Improvements in secondary batteries.** Pierre Anatole Fichet and Albert Nidon, 12, Rue Cassette, Paris, France. (Complete specification.)

15,375. **Railway electric fog signalling apparatus.** Frederick Simpkin, "The Elms," Brookfield-road, Victoria Park, E.

15,377. **Improvements in railways upon which the propulsion of vehicles is effected by means of both electricity and gravity, and apparatus in connection therewith.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C.

15,388. **Improvements in apparatus for regulating dynamo-electric machines.** Arthur Shippey, 321, High Holborn, W.C. (Addison G. Waterhouse, United States.) (Complete specification.)

15,394. **An improved electric miners' safety lamp.** George Collins Levey, 1, Queen Victoria-street, London, E.C.

15,395. **Improvements in instruments for measuring and regulating electric currents and differences of potential, partly applicable to telegraphic purposes.** Philip Cardew, 24, Southampton-buildings, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

NOVEMBER 26, 1887.

16,296. **Improvements in primary and secondary galvanic batteries.** Arthur French St. George and Christen Rees Bonne, 26, Mark-lane, London, E.C.

16,304. **Improvements in and relating to the manufacture of plates for engraving, stereotyping, and electrotyping purposes.** William Robert Lake, 45, Southampton-buildings, London. (Hoke Engraving Plate Co., Incorporated, United States.)

DECEMBER 2, 1887.

16,603. **Improvements in electric lamps, and in dynamos for the same, for velocipedes or the like.** Alfred Julius Boult, 323, High Holborn, Middlesex. (Richard Weber, Germany.)

DECEMBER 13, 1887.

17,155. **Improvements in incandescent electric lamps and cut-out devices therefor.** Thomas Alva Edison, 23, Southampton-buildings, Middlesex.

DECEMBER 20, 1887.

17,508. **Improvements in electrical switches.** Frederick Lawrence Rawson and William White, 1, Queen Victoria-street, London, E.C.

17,528. **A method and apparatus for phonic reception of telegraphed communications.** Clément Ader, 28, Southampton-buildings, London, W.C.

DECEMBER 23, 1887.

17,669. **Improvements in telephonic apparatus.** David Johnston Smith and Daniel Sinclair, 62, St. Vincent-street, Glasgow.

DECEMBER 24, 1887.

17,762. **Improvements in electric signalling apparatus.** Leopold Sellner, 45, Southampton-buildings, London.

17,768. **Improvements in apparatus for covering or insulating wire.** Willoughby Statham Smith, the younger, 24, Southampton-buildings, London, W.C.

17,770. **Improvements in apparatus for coating metal plates.** John Lysaght, 24, Southampton-buildings, London, W.C.

DECEMBER 27, 1887.

17,812. **Improvements in machines for the production of alternating electrical currents.** Charles Zipernowski, 28, Southampton-buildings, Chancery-lane, London, W.C.

JANUARY 2, 1888.

39. **An improvement in voltaic batteries.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London, W.C.

JANUARY 18, 1888.

804. **Improvements in electric clocks.** Martin Pulvermann, 4, South-street, Finsbury, London. (Carl Bohmeyer, Germany.)

JANUARY 31, 1888.

1,479 **Improvements in apparatus for indicating and registering payments, especially applicable for indicating and registering payments for the use of telephones.** Alexander MacGregor, 47, Lincoln's-inn-fields, London.

MAY 29, 1888.

7,826. **Improvements in galvanic generators.** Harry Barringer Cox, 46, Lincoln's-inn-fields, London, W.C.

JUNE 5, 1888.

8,170. **Improvements in and relating to automatically regulated electro motors.** Herbert John Allison, 52, Chancery-lane, London. (The Baxter Electric Manufacturing and Motor Company, Incorporated, United States.)

JULY 20, 1888.

10,524. **Improvements in electric railways.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Middlesex. (The Bentley-Knight Electric Railway Co., United States.)

SEPTEMBER 8, 1888.

13,008. **Improvements in electric incandescent lamps with interior reflecters.** John William Oldroyd, 8, Quality-court, Chancery-lane, London.

SEPTEMBER 11, 1888.

13,126. **Improvements in electric calls.** Willard Henry Cutting, 23, Southampton-buildings, Middlesex.

SEPTEMBER 25, 1888.

13,825. **Improvements relating to electrical conductors and insulating conduits therefor.** Henry Harris Lake, 45, Southampton-buildings, London, W.C. (Robert F. Silliman, United States.)

SPECIFICATIONS PUBLISHED.

1882.

1,830. **Transporting goods, &c., by electricity.** J. Fleeming. (Second edition.) 8d.

1887.

14,996. **Transmitting motion from electric motors to driving axles of vehicles.** E. Hopkinson. 8d.

15,760. **Electrolytic treatment of sewage and sea water.** W. Webster. 8d.

15,877. **Telegraphic apparatus for indicating the position of a ship's rudder.** J. B. Willis. 8d.

16,185. **Electric meters.** W. J. S. Barber-Starkey. 8d.

16,772. **Electric bells.** J. A. Macdonald. 6d.

1888.

8,611. **Galvanic belt for medical purposes.** W. Laughton. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	4¼
12 Feb.	2/0	— fully paid	5	5¼
26 Oct.	7/6	Anglo-American	100	47½
26 Oct.	15/0	— Pref.	100	79¾
12 Feb., 85	5/0	— Def.	100	17¼
28 June	3/0	Brazilian Submarine	10	13½
14 June	1/0	Con Telephone & Main	1	1/16
10 Aug.	9/0	Cuba	10	14
10 Aug.	10/0	— 10% Pref.	10	18½
12 Oct.	2/0	Direct Spanish	5	4
12 Oct.	5/0	— 10% Pref.	5	10¼
26 Oct.	2/0	Direct United States	20	10¼
12 Oct.	2/6	Eastern	10	12⅜
12 Oct.	3/0	— 6% Pref.	10	14⅝
1 Aug.	5%	— 5%, 1899	100	110
26 April	4%	— 4% Deb. Stock	100	110
12 Oct.	2/6	Eastern Extension, Australasia & China	10	13⅛
1 Aug.	6%	— 6% Deb., 1891	100	104½
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	105
28 Mar.	8/3	German Union	10	9½
12 Oct.	3/0	Globe Telegraph Trust	10	7⅛
12 Oct.	3/0	— 6% Pref.	10	14¼
30 April	5/0	Great Northern	10	14¼
1 March	5%	Gt. Northern 5% Deb., '83.	100	103½
27 July	10/0	India Rubber, G. P. & Tel.	10	17
11 May	37/6	Indo-European	25	39½
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
		Swan United	3½	2¼
10 Aug.	13½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	98
12 July	4/0	West Coast of America	10	8
30 June	8%	— 8% Debs.	100	115
11 May	9/0	Western and Brazilian	15	13¾
11 May	6/10½	— Preferred	7½	7⅛
11 May	2/1½	— Deferred	7½	7
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	2⅛
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80		— 6% 2nd Pref.	10	12
2 May	7%	West Union of U.S.	$1,000	125
1 Mar.	6%	— 6% Sterling	100	102

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NOTES.

Brussels.—A central electric light station is shortly to be established at Brussels.

Witten.—The Municipal Council of Witten, Westphalia, have decided to construct a central electric light station.

Gravesend Tramway.—Messrs. Dick, Kerr and Co. have the construction of the tramway in hand at Gravesend for the Series Traction Company.

Eastbourne.—The new contract between the corporation and the Electric Light Company for the lighting of the parades has been officially signed and sealed.

Paris Exhibition.—The sum of a quarter of a million francs has been voted for the establishment of luminous electric fountains in the Paris Exhibition.

The Subway Railway.—Notwithstanding constant reports to the contrary, we have ascertained that the subway contract has not yet been definitely settled.

Canton.—China is coming along with electric light. The Viceroy at Canton has just had 100 Edison lamps installed, and, if this pleases the Chinese, it is expected Canton itself will have a central station.

High v. Low.—The Chelsea Company are making great points among prospective customers that no dangerous wires will enter their houses. Better look sharp; the "high" tide is coming.

Norwich.—The preparations for a central station for Norwich are, we hear, in a forward state. Much of the machinery is in hand by Messrs. Laurence, Paris, and Scott. Callenders will supply the cables.

Montreal.—It is proposed to light the city of Montreal, Canada, throughout by electricity. An elaborate report has been prepared and submitted by the city electrician, Mr. F. H. Badger, to the city council.

Heisler System.—Vincennes, Indiana, is publicly lighted by 150 30 c.p. incandescent lamps on the Heisler system, on an eleven-mile circuit. The cost is only one-third that of gas, and the light is better.

Whose Fault?—The gas leaked, the lightning struck some electric wires, and the pavement, to the extent of many tons, heaved considerably in New York city the other day. Whose fault was this, we should like to ask.

Slaithwaite.—Three mills of the Slaithwaite Spinning Company have been fitted by J. H. Holmes and Co., Newcastle, with 430 lights. "Castle" dynamos, compound wound, self-regulating, slow speed, have been used to supply current.

The Brush Company.—It is stated that the apparatus used in the Brush installation at the Brussels Exhibition has been used for the works on the Meuse, and that the large projectors of Messrs. Bouckeart and Co. are to be sent to Russia.

Electric Sugar.—Cablegrams from America say that it has been resolved by the Sugar Refining Company to run for ten days without load in order to ensure certainty. Testing began on Tuesday, and so far the machinery is said to work well.

Long-Distance Telephones.—We understand the National Telephone Company has opened another important long-distance line from Sheffield to Birmingham. We may hope London may be within speaking distance of the North before long.

Denmark.—The first central station in Denmark has just been completed at the little town of Lyngby, close to Copenhagen, where incandescent lamps replace the petroleum lamps hitherto used. Several important installations in Denmark are also reported to be on hand.

Gas Conference.—A general conference is proposed by the gas journals to consider what course is to be taken with regard to the Deptford station. They consider the supply of electricity is being extensively undertaken without provisional order, and in complete defiance of the Electric Lighting Acts.

Sale of Lamps.—When the Deptford installation spreads its arms into the populous parts of the City, shall we have the oilmen selling glow-lamps; or is some one going to establish a glow-lamp emporium for retail buyers? The incandescent lamps will probably be as common as lamp glasses in those days.

Brussels Exhibition.—The official list of awards has been published, and will be found to be in accordance with what we stated in our issue of October 26—viz., that in Group 17 the Electrical Power Storage Company has been awarded a gold medal, while the Anglo-American Brush Electric Light Corporation has received a diploma of honour.

International Telephony.—A special section of the Paris Congress is to be devoted to telephony. An attempt is to be made, on the French initiative, to organise an international telephone exchange, of which the principal lines—Vienna-Metz-Paris, Berlin-Vienna-Rome, Metz-Amsterdam-London and Berlin-Brussels-Paris—will form the framework.

Converting Cowpen.—The Cowpen Local Board have not yet settled their dispute with the Blyth Gas Company, and in order to show the members and the inhabitants generally the effect of the electric light a large arc lamp has been placed by order of the board at Cowpen Quay. The motive power is supplied from the engine-room of the Blyth Shipbuilding Company.

Maxim-Weston.—It will be noticed from our advertisement columns that the reconstructed company—or perhaps we ought to say the re organised company—is making an effort to carry out work. There is no reason why, if the company is conducted on strict business principles, it should not obtain its proportion of the business which is being given out on every hand.

Tynemouth.—A member of the Tynemouth Town Council has suggested that it would be a graceful thing to withdraw the scheme for electric lighting altogether, as he said the ratepayers were opposed to it. If it is a question of grace, Tynemouth would be more graceful by removing its gasometers—abortions of engineering skill which electricity will eventually cure off the face of the earth.

Gadot Accumulators.—The accumulators made by M. Gadot have recently been improved, and the storage capacity is now given as practically 10 amperes per pound of plate (21·75 per kilogramme). The thickness of the metal casing has been decreased, the proportion now being 46 per cent. to 56 per cent. of paste. This corresponds to 57lb. of total weight of accumulator per horse-power hour.

Eastbourne.—The members, officials, and medical staff of the Kensington Vestry visited Eastbourne on Monday to inspect and report upon the working of the electric light now adopted by the Eastbourne Corporation for the sea front and municipal buildings. The mayor

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(Alderman Boulton) welcomed the London visitors at a public luncheon. The town is now illuminated with over 1,700 electric lights.

Society of Arts.—The 135th session opens on Wednesday, November 21, with an address by the Duke of Abercorn. Among the papers arranged for interesting to electrical engineers is one by Mr. W. J. Dibdin on "Standards of Light" on the Wednesday before Christmas. In the latter part of the session Mr. W. H. Preece, F.R.S., will read a paper on "Secondary Batteries." The juvenile lectures at Christmas will be by Prof. Armstrong, F.R.S., the subject being a chemical one.

Mansion House.—At the Court of Common Council Mr. J. Judd moved: "That it be referred to the General Purposes Committee to consider the best means of lighting the Mansion House by the electric light, to obtain tenders and estimates for the necessary works, and to submit them to this court, and that for this purpose the committee be authorised to expend a sum not exceeding twenty guineas." This was approved, after a protest from Mr. Morton that the expenditure was useless and wasteful.

Gorseinon Church.—Holy Trinity Church, Gorseinon, was lighted on Sunday, the 21st, by means of the electric light. Four lamps of 32 c.p. each were placed in the nave, and four similar ones in the transepts and chancel, with a large lamp of 500 c.p. in the roof. The permanent lights, however, are to consist of four lamps of 100 c.p. each in the nave, four similar ones in the transepts and chancel, and one of 16 c.p. in the vestry. The church is indebted to W. Lewis, Esq., of the Gorseinon Tin-Plate Works, for the light.

Johns Hopkins University.—The Johns Hopkins University has now, says the *Electrical World*, formally established its electrical testing bureau for the purpose of carrying on tests of all kinds of electrical apparatus. The staff of the bureau, at the head of which stand Prof. Rowland and Drs. Duncan and Liebig, has the highest reputation, and its facilities are unequalled. A report from Johns Hopkins will always be accepted as final, and it is hoped in the interests of electrical science, that the bureau may be given abundant opportunity of work in its special field.

Personal.—Mr. George Webb (eldest son of Mr. F. H. Webb, secretary to the Institution of Electrical Engineers) left on Thursday, the 1st inst., by the P. and O. steamer "Kaiser-i-Hind" for Bombay, to take up his appointment as assistant-superintendent of telegraphs on the Great Indian Peninsular Railway. Mr. Webb has been many years in the service of H.M. postal telegraphs in the mechanical and testing departments, having begun at the bench. Before leaving, he examined all the train electric lighting arrangements used on the London and South-Western Railway.

Removable Cut-Out Plugs. — M. Grivolas has patented a cut-out arrangement which will probably prove acceptable in English installations. The cut-out base has two sets of stout double springs, nickel-plated, into which a little oblong block, with contacts and screws for fuse wire, can be slipped. If a fuse goes, the block can be removed and another immediately inserted, while the damaged one can be refilled with fuse wire and kept for other emergencies. Messrs. Fowler, Lancaster and Co. have secured the English rights, and are also making china bases largely for the continental supply.

Arcs and Sparks.—A complaint has arisen in Philadelphia that the arc lights are too strong. Marriageable daughters tell their parents that the light shines into the rooms too strongly, and when their sweethearts call they have to put up awnings to secure a sufficiently "tender gloom." Even Romeo could not so sweetly whisper "soft nothings" with a 2,000 c.p. arc going opposite the balcony, and no doubt a sufficiently pathetic notice to this effect from a "marriageable daughter" would induce the electric company of Philadelphia to put up a blest shade, or move the arc to a more fitting resting place.

Accustoming Society.—It would strike us as funny in England to advertise electric light in the comic papers, yet this is what is done in Germany. In the *Fliegende Blätter* is an advertisement with a cut of an Edison rocket lamp of "the economical and constant glow-lamps" supplied by the Allegemeine Electricitats-Gesellschaft (late German Edison Company), Berlin. This is as if the Anglo, Cromptons, or the Grosvenor put an advertisement in *Punch* to accustom society to their names and systems. We have noticed advertisements in the daily press with this idea, but not yet in *Punch*, and we commend the idea to their consideration.

Dublin.—The Dublin Gas Company have served a notice on the corporation that they intend to apply for a provisional order to supply electricity as well as gas. The Dublin Corporation, however, will oppose this, as they wish themselves to obtain a provisional order. The corporation has now formally confirmed the resolution previously passed to introduce the electric light. It has adopted the report of a committee composed of the whole of the council, which recommends that application be made to the Board of Trade for a provisional order to enable the corporation to supply electricity for private as well as for public purposes.

Rivals or Allies.—The gas journals are waking up at last to their perilous position, and are advocating the policy wepointed out to them months ago. It certainly will be a case with many of these present companies of sink or swim, if the continued extension of their "rival" goes on without making it their friend. Says the *Gas and Water Review* for this week: "It would be well if gas companies would take some combined action, and secure the right to supply electricity as well as gas. This is very largely done in America. The public would have sound, established people to deal with"—— who will, we would remark, only remain sound and established by reason that they do so take action.

North Metropolitan Cars.—The electric cars for the North Metropolitan Tramway, at Canning Town, are now in an advanced state of preparation. The motors are ready, and 600 double cells are on order at the E.P.S. Company. It is generally expected that the arrangements will be in practical working order by Christmas, and that the line will be handed over to the Electric Traction Company to run by stored electricity, instead of horses, by the beginning of the new year. Many tramway companies are waiting the result of this trial, and the favourable certificate of the North Metropolitan would result, without doubt, in a very general adoption of electric traction in English tramways.

Ward Electric Cars.—We notice the forming of the Ward Electric Car Company, with a capital of £300,000, for purchasing and working the patents of Mr. Radcliffe Ward, whose electric omnibus we mentioned a short time ago as having been tried in the early hours in the London streets. A great field is regarded as open among railway delivery vans for electric road traction, as in these vans

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heavy goods have to be drawn, and more time is now spent in waiting when collecting and delivering goods than in actual traction; very strong horses have to be used, which more than half their time are standing still. With electric cars energy would only be consumed when actually in motion. It is also hoped that electric omnibuses may be sanctioned for ordinary passenger traffic.

Card-Telegrams.—A new scheme of card-telegrams is being tried in Hungary, for use in districts having a post-office, but without a telegraphic service. Cards are sold at the post-office at the price of 35 kreutzer for five words, excess to be paid for by additional postage stamps to be affixed at the corner. The telegram can be put in any letter-box, and is forwarded to the nearest telegraph-office, and from there it is despatched without further delay or charge. It is not so generally known to the public as it might be, that in England telegrams can be posted at any pillar-box, and will be sent on from the nearest telegraph-office. Some such scheme of special forms for this purpose in the shape of card-telegrams might render this of greater practical utility, and the example of Hungary is worthy of the attention of the Post Office authorities.

Electro-Culture.—There has been an idea floating in the minds of scientific agriculturalists that currents of electricity applied to root crops might have some beneficial effect. Prof. E. Wollny, of Munich, has made some exact experiments on the subject. He took patches of ground 12ft. or 13ft. square, separated by boards penetrating the earth to the depth of a foot. In one case he applied two earth-plates, and interposed five cells; in another, he inserted an induction apparatus; and in a third a plate of copper at one side and a plate of zinc at the other side, to form a natural battery. Peas, potatoes, carrots, &c., were planted on these and other patches, but the electricity, whether of high or low potential, seemed to have either no influence, or a bad one, upon their growth. Prof. Wollny believes the electricity does provoke perturbations on the protoplasm, the more that sap with which the plant is filled is a fair conductor; but he thinks that electro-culture will never become of any practical utility.

The Royal Society.—The following is the list of names recommended by the President and Council of the Royal Society for election into the council for the year 1889, at the forthcoming anniversary meeting on the 30th inst.: President, Prof. George Gabriel Stokes, M.A., D.C.L., LL.D.; treasurer, John Evans, D.C.L., LL.D.; secretaries, Prof. Michael Foster, M.A., M.D., and Lord Rayleigh, M.A., D.C.L.; foreign secretary, Prof. Alexander William Williamson, LL.D.; other members of the council—Prof. Henry Edward Armstrong, PhD., Henry Bowman Brady, F.G.S., Charles Baron Clarke, M.A., William Huggins, D.C.L., John Whitaker Hulke, F.R.C.S., Prof. John W. Judd, F.G.S., Edward Emanuel Klein, M.D., Prof. E. Ray Lankester, M.A., Prof. Herbert M'Leod, F.I.C., Sir James Paget, D.C.L., William Pole, Mus.Doc., William Henry Preece, M.I.C.E., Sir Henry E. Roscoe, D.C.L., Edward John Routh, D.Sc., Prof. Arthur William Rücker, M.A., Captain William James Lloyd Wharton, R.N.

Paris Tenders.—The commissions appointed to consider propositions for the municipal central station at Paris met on October 25. For the electric apparatus eight tenders were received from the following: The Edison Company (Paris), La Société L'Eclairage Electrique Jablochkoff (Paris), La Société Alsacienne (Belfort), La Société Lyonnaise (Paris), M. Victor Popp (Paris), M. Octave Patin (Nancy), concessionaire of the Ferranti system in France, M. Fabius Henrion (Nancy), MM. Cuenod Sautter and Co. (Geneva). The Oerlikon Company asked to compete, but did not finally tender. For boilers the following tendered: MM. Belleville (Paris), Babcock and Wilcox (Lille), Daydé et Pillé (Paris), Roser (St. Denis), and for engines MM. Douane et Jobin (Paris), Thomas Powell (Rouen), Lecouteux et Garnier, Dujardin, Bietrix, Boulet et Cie., and La Société Cail. Proposals for complete installation of engines, boilers, and dynamos were received from La Société Lyonnaise, MM. Weyher et Richemond (Pantin), La Société Alsacienne, and M. Victor Popp. The result will be published in a few weeks.

Deptford Station.—It is proposed to make the supply of current from the Deptford station continuous, and available at all hours of the day and night. The following is the scale of charges at present fixed. The price is calculated to be equal to about 4s. 2d. per 1,000 for gas. The charge by the London Electric Supply Corporation will be by meter, at the rate of 7¼d. per Board of Trade unit, but for special installations having very large numbers of lights, the directors will, if preferred, contract to supply current at a fixed rate per lamp per annum, based upon estimates of the proposed use to be made of the light. The corporation requires in all cases a guaranteed minimum rental of £20 per annum. In addition to the charge for current supplied, the following charges will be made for appliances which are the property of the corporation and are maintained at its expense: Meter, £1 per annum; transformer, fuses, switches, &c., for installation of forty-five lamps of 10 c.p. and under, £1. 10s. per annum; and for all additional lamps up to 100, 6d. per lamp per annum; up to 200 lamps, 5d., and above 200 lamps up to 1,000 lamps, 4d. per lamp per annum for transformers and apparatus.

Inexpensive Carbon Plates.—A writer in the *Scientific American* advocates the use of cast-off electric light carbons for making plates for a small motor battery. In any electric light station, he says, numbers of carbon ends can be had for asking. To prepare these the copper coating is removed by nitric acid, taking care to leave about one or one and a half inches of copper on one end of each rod. When taken from the acid they should be washed and dried, then placed in a holder and wedged together, having all the copper ends together. Apply soldering acid in the grooves between the coppered ends, and with a soldering copper, heated just enough to melt common solder, rub the solder in until it "takes," which will be in a moment. When one side has all the grooves filled, turn the plate over and repeat the process on the other side. Before using the plate in the battery, it should be coated with paraffin for about ½in. below the copper, and the paraffin should be worked into the grooves, otherwise the acids from the battery would be drawn up by capillary attraction and soon destroy the copper, and cause the rods to fall apart. These plates are equal to any manufactured for battery purposes, and in some cases superior, as the carbon rods are very compact and of fine texture.

Competition.—The typical American is, perhaps, one of the keenest business men existing upon the face of this globe, but even he is beginning to see that there may be an excess of competition, and we find that suggestions are being made as to caution in this direction. We have heard friends from the other side describing with that inimitable brogue of theirs that manufacturers do not want the machines they sold to last for ever, nor do contractors agree to put in work that should stand through ages.

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We prefer, said one *vis-à-vis*, to have a change about every twenty years, if not sooner, so that there may be more trade going. However correct this may be from a business point of view, we are glad to see such remarks as the following, as they indicate the tendency of thoughtful men in America : "In harnessing electricity and subverting it to the uses of men, it is more necessary to have perfection—absolute perfection—n the various accessories than in any other of the great forces, for of all of them electricity is the subtlest and the hardest to control. Hence, we wish to say to manufacturers, construction and supply companies, do not ruin the business by unbusiness-like competition in your anxiety to secure trade ; and to the contractor and builder, do not be dazzled by low prices in either electrical machinery or construction, but be sure you have the best and be willing to pay a fair price for it.

Business.—Having to be in Birmingham this week to see the trial of the new Julien electric locomotive, a report of which will be found elsewhere, we took the opportunity to visit some of the principal electrical engineers of the metropolis of the Midlands. Here, as elsewhere, we found signs of unceasing and increasing activity in our special branches. Business is good, was the universal reply. Messrs. Chamberlain and Hookham are busy with many undertakings. Messrs. Fowler, Lancaster and Co. are very busy with their speciality of china fittings, and have orders for 10,000 pieces on hand. They cannot get the china switch, fuses, &c., out fast enough, large quantities going on the Continent, where they have an exclusive patent for screwed china. Besides this, they are very busy with fitting up houses, and are wanting good wiremen. Messrs. R. W. Winfield and Co. have got out a number of new light electric pendants and brackets of shapely design. Messrs. Elwell-Parker, Limited, of Wolverhampton, are extremely busy with work of all sorts, alternate and direct dynamos, depositing plants, and great things are expected with the new electric engine and tramway work generally, in regard to which they are working with the Julien Company. Some idea may be judged of the extension of their business when it is mentioned that they shortly contemplate extending their works—already occupying some four acres—by twelve acres, the land for which has already been acquired.

Bursting of Reservoir.—The reservoir for the electric railway at Montreux, near Chillon, Switzerland, burst on Tuesday last, with fatal results. Montreux ranks as one of the most lovely spots in Europe, and is a great favourite with invalids as a winter resort. The reservoir for supply of water-power for an electric railway has recently been constructed in one of the upper clefts or indentations of the hills. Shortly before noon the principal embankment suddenly yielded to the pressure of the water within, swollen by the recent heavy rains, and before any warning could be given to the occupants of the houses and villages lower down the valley, the flood poured through the opening in a resistless tide, sweeping everything before it. The stream tore up and carried with it pebbles and masses of rock. The villages of Souzier, Pertit, and Vernex were laid waste by the deluge, and many persons drowned, and the railway line which runs along the borders of the lake, and connects Montreux with Vevey, was rendered temporarily impassable. In several cases the unfortunate inhabitants of houses on the track of the inundation were swept out of their beds by the fierce rush of water, or crushed by the crumbling of the walls. The loss of life at present discovered is comparatively small, and there is reason to hope that the number who have perished will not much exceed ten. It is to be hoped that electrical engineers will follow of themselves the best engineering principles in the construction of water reservoirs, which are well enough known. It is deplorable that an accident of this nature should be connected with the schemes of electrical engineers.

Mill Lighting in Halifax.—While central station lighting has been developing all round, mill lighting has also been proceeding apace, and one of the largest installations of this kind has just been completed at a new mill in Halifax, belonging to Messrs. Hollingrake and Clegg, worsted spinners This new mill is devoted almost entirely to the spinning of coloured yarns. Unless one were to see the yarns in progress, it would scarcely be conceived that so many colours were used in men's clothing. The variety of shades is almost numberless, and it is the difficulty of working up these coloured yarns in gaslight that has led the firm to adopt the electric light. The installation has been carried out by the Schmidt-Douglas Electric Company, Limited, of Bradford, who, it may be remembered, are at present proposing to the corporation to light the borough of Halifax, and whose application is at present under consideration. The dynamo is a very large one, weighing six tons, and supplies current to 60 arc lamps of 2,000 c.p. each, and 500 incandescent lamps of 16 and 32 c.p. each. The belt driving the dynamo is 18 inches wide, made by Messrs. Hebblethwaite Brothers, of Huddersfield. Power is obtained from the mill engines. The light is supplied to every department of the mill, from the fine engine house to the top room. In the bottom room of the mill, where are carried on drawing and roving, incandescent lamps are used, the number being the same as the gas-lights formerly used. The result is all that could be desired—a pleasant, steady light, much more than equal to the gas, and without the heat and dirt arising from it. Adjoining this floor is a shed used for warping and winding. Here the contrast with gas is much more marked. Eight arc lamps are inserted, which give a pure and beautiful light, so that the operatives find no difficulty at all in working among the delicate shades of material. In another part of the shed warping is carried on, and for that department the incandescent lights of 32 c.p. are used to each warping mill. The recombing of dyed wool is done in an adjoining shed, which is also lighted with arc lamps. The two colour-matchin rooms have respectively two and four arc lights, which give a most soft and cheerful appear ance. The spinning and twisting departments are lighted with incandescent lamps throughout, and in the fifth or top room, devoted to drawing and roving, there are two rows of arc lamps, 16 in all, used again with excellent effect. The colours of the yarns show almost as clearly as in the daytime, and there is no difficulty in defining the fine shades. The confidence of the contractors in their installation is shown by their undertaking to maintain the system, and keep it in good repair, at a fixed amount, for a period of seven years.

Electricity as an Employment.—Mr. Francis B. Crocker has been inciting the young men of New York to become electrical engineers, or to become connected therewith. It does not require, he says, a peculiar individual ; it is not necessary to let your hair grow long to be an electrician, but a man of intelligence, with education and experience, is always eligible. A course of training at a college is advisable, but self-education is perfectly possible, and some of the best results have been thus obtained.

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Edison himself is an example. Persons generally stand too much in awe of understanding, or even partially understanding, a subject by their own exertions, and endeavours should be made to thoroughly understand even that which at first appears beyond one. A daily contact with electrical things in a factory or station will rapidly improve and increase the knowledge. The next point to decide is what branch or application of electricity to select. This depends somewhat upon the individual; in most cases a young man would probably take the first good chance offered. But as a man can usually steer his own course more or less, it is well to know which way it is wise for him to try to go. It is considerably easier to go with the current than against it. In other words, there are some applications of electricity that are advantageous and easy of themselves, and some that are not, and if a man takes up one of the former class he is likely to be comparatively successful, whereas, if he takes up one of the latter classes, he will have uphill work, entirely irrespective of his own industry and intelligence. To take extreme examples, electricity will run these arc and incandescent lamps very satisfactorily, but so far it has not been found practicable, or anywhere near practicable, to run an ocean steamer by it. Anyone taking up arc or incandescent electric lighting as a business will probably do well, but if anyone was visionary enough to attempt making a business of building or operating electric ocean steamers, he would be very apt to die in the poor-house or lunatic asylum. Of course, it is possible that all this may be changed at any time by new discoveries, but all one can do is to judge by what is already known, and in the case of a beginner it certainly is not wise to go beyond this. To carry this idea still further, one can judge of the likely directions of electrical progress even before the advance occurs, and it is in one of these favourable directions that a man should try to go. The generation and distribution of electricity for light, power, and other useful purposes is a very good branch of the business to choose, because it is the fountain head, and all electrical progress will probably benefit it. The propulsion of street cars by electricity is just now of particular importance, and this business is destined to be of great magnitude, and one eventually demanding the employment of hundreds of intelligent young men to run the central generating stations. The telegraph, which is the oldest and best established electrical business, is still a pretty good field. The telephone, which is financially the most successful of all, is a better field. Lighting is growing very rapidly, and will spread still faster in the future. Motor manufacturing and renting is one of the most promising branches.—*Scientific American.*

Novel Exhibits.—In the electrical section of the Cincinnati Exhibition there are a number of interesting or novel exhibits, illustrating the use of incandescent lamps. The extent of these exhibits may be best understood when it is mentioned that four large Edison dynamos, giving a total of 1,300 amperes, together with 2,500 Edison lamps and a Corliss engine of 250 h.p., are used, not for lighting purposes, but for novel electrical effects. These effects include a large cascade 25 feet high, studded with coloured lights. The lights are made to chase up and down the cascade, twinkle, oscillate and change colour, and disappear, producing very charming effects. Over the cascade is a series of lamps arranged as a rainbow, composed of a hundred lamps of the various rainbow hues, which is made to appear slowly and fade away, or flash and scintillate and produce other effects. The appearance of the rainbow in conjunction with the cascade is extremely beautiful. Coloured lamps are arranged as flowers in eighteen different baskets, constantly blooming forth and flashing with light. Horned owls, seated above the bridge, blink, looking wise and melancholy, with electric eyes. Stars, moons, and crescents of lamps among the rocks keep up a continued flashing. In the galleries are numerous globes containing coloured solutions, in which hang electric lamps. A fountain in the garden is filled with submerged lights, and four crystal fountains are each surmounted by a huge electric soap-bubble of glass, tinged with delicate tints. A Japanese parasol, among tropical plants, spins and flashes, each tip an incandescent lamp. One of the most attractive exhibits is the mysterious electric fountain, which hangs in a lovely basket of flowers, suspended by a wire from the ceiling, and yet plays continuously a column of spray high into air. This attracts crowds of visitors, who wonder where the water comes from; the explanation is a very small motor and water pump in the bottom of the hanging vessel. An immense electrolier of two hundred lamps hangs in three rings of light to illuminate the conservatory, where hover birds carrying lamps in their beaks, and floral ornaments innumerable. In the grounds a fountain rising to the height of 60 feet is surrounded with a dome of 400 lamps, which flashes to the time of the waltz-music of the band. Down the main aisle are a series of huge Japanese fish, 20ft. long, the inside of which are filled with lamps connected to a revolving switch kept in constant movement by a motor, causing the various fish to flash up one after the other, and giving an appearance as if one huge illuminated fish were swimming down the hall to plunge into the electric fountain at the end. At one end of the building stands a huge Christmas tree 35 feet high, loaded with electric lamps and candles and quantities of good things which delight the children. The lamps, some 150 in number, are arranged in a dozen circuits, and, as the tree rotates by electricity, they are automatically switched off and on, producing a beautiful effect. On the base is a Centennial emblem, made of lamps in colours which form the figures 1788 and 1888. A huge revolving tropical garden, 65 feet in circumference and weighing several tons, is composed of tiers of blooming flowers, ferns and vines, from among which spring 150 beautiful crystal flowers, each illuminated with a coloured electric lamp. This huge garden revolves by means of a motor, and its sets of circuits are alternately brought into play, causing the electric flowers to bloom and die. Further down the aisle stands the monster Edison lamp, constructed by Mr. Hammer for the Edison Lamp Company. It is over 30 feet in height, and is composed of some 15,000 perfect Edison lamps. It represents a huge Edison lamp and socket mounted on a pedestal. The globe alone requires over 73 barrels of lamps to fill it, and is the biggest exhibit in the exhibition. Many miles of wire were required in this work. Mr. W. J. Hammer designed and superintended the various effects under arrangement with the Edison Company of the district, and in its preparation no expense was spared to make it first-class in every respect. Mr. Hammer imported his most skilled help from New York, and was assisted in the construction work by Mr. J. C. Metzger, of Cincinnati. The president of the exhibition is very pleased with the result, and Mr. James Allison says: "This portion of the exposition is alone worth going many hundreds of miles to see." The effect, as seen in the evening, impresses everyone most forcibly with the wonders of electric light.

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NOTES ON CHOOSING AND INSTALLING ELECTRIC LIGHT PLANT.

BY L. A. DAVIES, A.S.T.E. AND E.

(Continued from page 343.)

Having briefly pointed out the principles which should be borne in mind when purchasing a dynamo, the next thing is to consider those which should guide an intending user of electric light plant in selecting a motor to drive his machine.

Although the rapid increase of central stations shows that, as a general rule, the time for separate complete installations is nearly gone by, at any rate in towns, and although it has been proved that the most profitable plan is to generate electricity in large quantities and to distribute it to consumers in the same manner as has been done in the case of gas and water, there are yet many large private houses, hotels, &c., which are unlikely to come within the radius of a central station for a long period, if ever. In these cases a special motor plant will be needed. There are also many cases, such as factories, collieries, mills, and ships in which there is ample engine power already installed.

By far the cheapest source of power at present known—leaving out for the moment the turbine, which presupposes a local gift of water-power—is a steam boiler and engine. We have also gas and petroleum engines, but the cost of power of the three in the above order, and taking steam as unity, is about 1, 6, and 8. We will therefore begin by considering steam plant.

As in the case of all other machinery, it will be found to be far the most economical plan to pay a little more at first, and get a thoroughly good boiler and engine, than to buy a second-rate article and spend a great deal more than the difference in the course of a few years in repairs. The chief item of running cost is the coal bill; and it is here that the advantage of having put down a well-designed boiler and an engine using a minimum quantity of steam will be felt. A pound of Welsh coal properly applied will evaporate as much as 9lb. of water, but the weight of coal consumed per indicated h.p. per hour may be as low as 1·5lb., or as high as 7lb. A difference of 5lb. per brake horse per hour in an installation of fifty 16 c.p. lamps means a difference of over £17 per annum one way or the other, and this saved means the rapid recoupment of the slight extra first cost of the less wasteful engine and boiler, besides the saving of the additional labour of shovelling in the extra 22 tons of coal.

One h.p. nominal means, as a rule, about 3 indicated h.p., and $1\frac{1}{4}$ i.h.p. means about one brake horse, or one nominal horse about 2·4 brake horse. This is in the case of steam-engines, in that of gas and petroleum engines one horse nominal means only about 1·6 brake horse. Nominal horse-power is now only a commercial expression. It was formerly calculated from the area of the piston, but the ordinary working pressures and speeds of engines have greatly increased of late years, and the term has now no exact meaning. By i.h.p. is meant the actual h.p. generated in the cylinder as calculated from indicator diagrams; and brake h.p. is this value less the percentage absorbed in working the engine itself, and represents the actual available power of the engine. A smaller unit of energy is the watt, or $\frac{1}{746}$ of one h.p., and this is the unit generally used in electrical measurements of energy. One unit of current × one unit of E.M.F. (or 1 ampere × 1volt) = 1 watt, so that a 16 c.p. lamp requiring ·6 amperes, at an E.M.F. of 100 volts, absorbs 60 watts, or $\frac{1}{12\cdot4}$ h.p. We should not get 12·4 such lamps per brake h.p. on the engine, because we must make some allowance for loss of power in transmission by belting and countershafting (if used), by absorption during conversion in the dynamo, and by absorption in the leads. But, supposing a dynamo of 85 per cent. efficiency and leads calculated at a current density of 1,000 amperes per square inch of conductor section, the conductor of 98deg. conductivity, and the lamps 50 yards from the dynamo, and neglecting the loss through slipping of the belt, we get 70·5 watts of brake energy required on the engine per 60 watt lamp, or, roughly, 10 lamps for every brake h.p. on the engine driving pulley. Knowing this, it is easy to calculate the size of engine need for an installation.

The difference in price between two-cylinder high-pressure simple engines and similar engines of equal power, but compound, is about 20 per cent. in favour of the former, taking an average over sizes varying from 30 to 120 i.h.p., but, as explained above, this difference will soon be counterbalanced by the smaller consumption of steam in the latter, the ratio being about two to one in favour of the compound. A further economy of steam is effected by governing the cut-off of the steam in the cylinder by means of automatic expansion gear. This gear consists of a link motion connected to a slide-valve rod regulating the admission of steam to the valve chest; governor balls raise or lower a die working in a slotted link on the end of the slide-valve rod, according to the speed of the engine and their corresponding centrifugal tendency to fly out and upwards. By this means, a later or earlier cut-off of the supply of steam to the piston is obtained, and the engine works at a greater or less rate of expansion according to the load put upon it. This gear, consequently, not only economises the steam, but tends to maintain the speed constant under a varying load.

Up to a certain limit, the more expansively an engine is used the more economically is each h.p. obtained. In non-condensing engines the limit to which the steam can be usefully expanded is reached when the pressure per square inch on the piston is only slightly above that of the atmospheric pressure. To obtain the utmost economy, it is plain that the maximum initial pressure that can be practically obtained should be employed. Experience shows this to be about 150lb. per square inch above the atmospheric pressure. Much greater pressures than this have been used, but there are great difficulties in producing them, and they are detrimental to the working parts of the cylinder. The usual limit is 140lb., or 155·5 absolute.

To make it more clear how great an economy results from working expansively, let us take the case of an engine having a piston $10\frac{1}{2}$in. diameter, 14in. stroke, and running at 120 revolutions per minute, and working at an initial pressure of 100lb. The power developed in this engine would be

$$\frac{86\cdot59 \times 100 \times 14 \times 120 \times 2}{12 \times 33{,}000} = 73\cdot3 \text{ h.p.}$$

if steam were admitted to the cylinder throughout the stroke; the heat units consumed and quantity of water used, supposing the water to enter the boiler at 60deg. F., would be

Water used per h.p. per hour

$$= (\cdot7 \times 240 \times 60) \div 239 = 42\cdot5 \text{ cubic feet, or } 2{,}652\text{lb.}$$

The heat units absorbed per h.p. per hour would be

$$\frac{(337 - 60) \times 2{,}652}{73\cdot3} = 9998\cdot \text{ units per h.p. per hour.}$$

Now, let us suppose that steam at the same initial pressure is used, but is cut off at $\frac{1}{8}$th of the stroke. Obviously only $\frac{1}{8}$th of the former quantity of water will be used, or

331·5lb. per h.p. per hour,

and the heat units employed to raise this to the necessary temperature (337deg.) will also be $\frac{1}{8}$th of the previous value, or

91759 units per hour.

The h.p. developed will now be

$$\frac{86\cdot59 \times 38\cdot5 \times 14 \times 120 \times 2}{12 \times 33000} = 28\cdot28 \text{ h.p.,}$$

therefore, the units per h.p. hour =

$$91759 \div 28\cdot28 = 3244,$$

as compared with 9998 units in the first case, or an increased efficiency of 208deg.

It is apparent from this, the most economical steam-engine is a compound worked expansively at a high initial temperature, and still more so if governed with automatic expansion gear.

Before leaving the subject of steam-engines some mention should be made of the large and increasing numbers of high-speed engines intended for coupling direct to dynamos and to be fixed on the same bed-plate with them. The Willans engine

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is usually either compound or triple expansion, the cylinders being placed one above the other in tandem. Sometimes two or three of these tandem sets of cylinders are set side by side, working on to one crank-shaft. The cranks dip into oil, and are completely cased in to avoid splashing and to keep all dust and dirt away from the moving parts. These engines use about 30 to 35lb. of water per brake h.p.

The Westinghouse engine is one that has been very largely used for electric lighting on the alternating-current system in America. It is usually compound, the two cylinders being side by side. This engine is controlled by a very ingenious centrifugal governor fixed within the fly-wheel, and acting so as to throw a sheave more or less out of centre on the crank-shaft, and so causing a longer or shorter stroke on a valve-rod connected to a strap riding on the periphery of the sheave. The water consumed per brake h.p. in non-condensing engines of this type averages about 25lb. The engines are also completely cased in, and the cranks dip into oil.

The Parson's steam-turbine is a totally different type of engine, as it contains neither piston or cylinder. Roughly, it may be described as a system of vanes carried on a central shaft and enclosed. Steam is admitted to the first vane, and exhausted from one to the next throughout the whole series, until it is exhausted finally into the air at but a very slightly higher pressure than that of the atmosphere. These engines run at the enormous velocity of 14,000 revolutions per minute. They occupy but very small space, and have been considerably used for ship lighting, where space is of the first consideration. Their water consumption is about 50 to 60lb. per brake h.p. per hour.

Boilers should be fitted with an injector or a donkey-pump, as it is highly important to be always secure of being able to maintain a sufficient level of water, and though there is often a pump on the engine, worked by an eccentric on the crank-shaft, yet, as this is only available when the engine itself is running, it cannot always be counted upon; besides, pump valves *do* occasionally get out of order.

Gas and petroleum engines are not so economical as steam-engines, the cost of running for fuel being in the proportion of 6, 8, and 1 in the order named. They have, however, several special advantages, and can be used in places where it would be impossible to put down a boiler and steam-engine.

Gas-engines, of course, imply a supply of gas, but petroleum-engines are quite self-contained, and need nothing save an occasional refilling of the oil reservoir. Till recently no gas-engine took a charge of the explosive mixture of gas and air oftener than once in two revolutions, but we have now the Griffin, exploding twice in every three revolutions, and the Stockport, once in each revolution. The makers of the last-named engine are bringing out a two-cylinder engine, of the tandem type, so as to obtain an impulse on the crank twice in each revolution, and this should render it possible to obtain absolutely steady running, a desideratum which cannot be said to have been reached as yet. This unevenness of running is not of so much consequence, when the installation includes accumulators, so long as the E.M.F. of the dynamo at the lowest speed does not fall as low as the back E.M.F. of the cells; but when the lamps are run direct from the machine a slight undulation is noticeable in the brilliancy of the lamps in an incandescent installation. This can, however, be almost entirely eliminated by the use of a heavy fly-wheel on the dynamo as well as on the crank-shaft of the engine.

The proper place for gas and petroleum engines is in small installations, with a maximum of 150 60-watt lamps, as up to the present these engines have not been proved to be satisfactory in larger sizes.

Gas-engines consume from 25 to 30 cubic feet of gas per brake h.p., so that the actual cost of fuel, when running with gas at 3s. per 1,000 cubic feet, can be placed at 1d. per hour per brake h.p.

Petroleum-engines cost for fuel, when running, about 1¼d. per brake h.p. per hour, with oil at 6d. per gallon.

The average prime cost of gas-engines per brake h.p. up to 12 brake h.p. is about £27, or about £2. 14s. per 60-watt lamp.

For petroleum-engines it is about £29, or £2. 18s. per 60-watt lamp.

These engines take up a very small amount of space, do not require expensive foundations, do not add to insurance rates, do not require much attention, are always ready to start, make no smoke, and in the smaller sizes show considerable economy. It will be seen that they offer many advantages. Their net weight averages about 4 to 6cwt. per brake h.p.

(To be continued.)

THE "JULIEN" ELECTRIC LOCOMOTIVE AT BIRMINGHAM.

The problem of running the tramcars of Birmingham by electricity, is one which offers greater difficulties to be overcome than is the case in many towns. Long and heavy cars are now run by separate steam-motors of large power, the gradient on the route being in some cases exceptionally heavy. The Birmingham Central Tramways Company have, however, taken the question up and decided to attempt the running of their cars by electricity. It was open to them to try the methods of conductor systems, overhead or underground, by means of which sufficient power could have been transmitted to run up these heavy grades. But the questions of cost, of disturbance to the line, and of traffic management induced the company to favour the scheme of accumulator cars, and they have selected the Julien system, already successfully applied in Brussels and on the Fourth-avenue Street Railway in New York, as well as in Melbourne. They have, therefore, arranged with Mr. Julien that an experimental car should be constructed by Elwell-Parker, Limited, of Wolverhampton, and we were invited to the trial of this car on Wednesday last.

The conditions laid down by the tramway company for the employment of electricity were as follows: First, the construction of a locomotive able to draw the existing cars of the company, without alteration or conversion of form, along any of their steam routes, and particularly up Bradford-street, which is half a mile long and has a gradient of one in eighteen, and in one place one in seventeen, and has been regarded by many engineers as an insuperable barrier to the employment of electricity along that route; secondly, it has been required that the cost of traction and depreciation should be comparable with that of steam locomotion; and, lastly, that the electric locomotive should be able to perform a full day's work of sixty miles without recharge. The Julien system has hitherto identified itself with self-contained cars, but these conditions were such that it was found to be practically impossible to satisfactorily carry out the undertaking with a self-contained car, and a separate electrical engine to take the place of the steam-engine was decided upon.

Several preliminary trials of this car have taken place, but owing to the new conditions involved in the large power of the motor, the gearing, which was originally a chain gearing, proved too weak, and helical gearing was substituted. The formal trial of this electric locomotive and tramcar took place before numerous representatives of the technical and daily press, visitors, and gentlemen connected with the interests of the Birmingham Corporation (among whom was the mayor and the late mayor, several councillors, &c.), and also representatives of various tramway companies, including the managing director of the London Street Tramways Company. The trial was in every way a success, and demonstrated—to the expressed thorough satisfaction of Mr. M. J. Smith, the managing director of the Birmingham Central Tramways Company—the possibility of replacing the monstrous and dirty steam-engines that now haul the cars, by equally efficient electric locomotives.

The electric engine is a compact and neat-looking arrangement of about, say, one-third the size of the huge and unshapely steam locomotives. It is covered with sheet iron, painted and decorated in harmony with the car, and has the name "Julien" in conspicuous letters on its sides. It has a door at each end, and a gangway down the middle, in which stands the driver, and is fitted with the controlling switch, numbered 0 to 5, and worked

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by wheel handle; a reversing switch; the engine brake (a rotary hand break); and a lever break for the passenger car. The engine is fitted with ordinary car connections for hitching on. On each side of the centre, under boarding, are placed the accumulators, and at the bottom, hung low down, suspended on iron framework, is the motor. This is a specially made Elwell-Parker motor, 14in. armature, running at 700 revolutions, and capable of developing at full power, with 200 amperes, up to 40 h.p. It is usually worked at about 6 or 7 h.p.; but on the up grade at Bradford-street would develop probably 30 h.p. with a full load. The motor is therefore well over its work.

The accumulators consist of a set of 104 cells, 39 plates in each cell, size 9in. by 6in. These are arranged so that by movement of the controlling switch they can be connected all in parallel, two in series-parallel, three in series, or all in series. No resistance is used, but a special contrivance of contacts is introduced to prevent sparking or turning on the current. One noticeable feature is that the engine switch is so arranged that it breaks the current itself when it is applied, and the control switch must be put back to zero in order to again connect the cells. This prevents mistakes, and adds certainty in stopping the cars. The engine is also fitted with a sand-box, with handle, for use in slippery places, lubricator tubes for the motor and gearing, a bell for warning, and the whole is covered with sheet-iron awning.

The gearing, as we have already mentioned, was at first attempted with chains and sprocket wheels; but on trial it was found that the motor, at its greatest power, simply tore the chain asunder link by link. Cog-wheel helical gearing was then tried, with perfect success. No difficulty has been found with running, and the motor is practically noiseless. Double helical gearing is used. In this, the surface of the cogs are in the form of an obtuse angle, fitting together, and the cogs themselves curved in the form of a right and left screw. The rolling contact is practically perfect, and the strain, never being on a single tooth only at any one time, allows the full power to be put on without jerk or danger to the gearing. Some improvements specially applicable to electric motor cars have been made in this gearing by Mr. Parker. These were not explained, as it is his intention to patent them. The gearing in this case was made of yellow metal, but steel gearing will be employed in future cars. The motor makes 700 revolutions at a speed of 10 miles an hour, and is geared down in the proportion of 8½ to 1.

The passenger car was one of the ordinary cars now usually drawn by steam, licensed to carry forty-four passengers, but as many as sixty passengers were carried in the trial trip, the car being full inside and out, the locomotive also carrying several passengers. Two incandescent lamps were fitted to the passenger car, to be supplied by current from the accumulators.

The start took place from Station-road about 2.40 p.m., the locomotive carrying the tramway company's representative, who gave instructions as to the Board of Trade "stops," the driver, and the representative of the *Electrical Engineer*. The car was driven on this occasion, for the Elwell-Parker Company, by Mr. Ted Parker (son of Mr. Parker), who, cold and dirty though the work made him, seemed to thoroughly enjoy the excitement and responsibility. His general air of intellectual appreciation and capability, and bright eyes, with a "bump of constructiveness" almost as big as Edison's, should mark him out for a remarkable engineering career. Mr. Parker accompanied the trial cars in a cab. The route was a most trying one in all respects, up and down hills, round corners, among crowded thoroughfares, and over crossings; but the car was under complete control, started evenly and easily, moved away without noise or jerk, stopped or backed with its full load, as the driver was instructed. Through the town, amid busy streets, past a wedding and a funeral, the car glided along, its appearance, with its large complement of passengers, attracting attention all along the route. The question of electric traction is regarded with very great interest in the district, as the ugly appearance of the steam monster, together with the greater disadvantage of whiffs of black smoke and sulphur, render the present system very obnoxious to the householders along the route. The car ran quite easily along the level and down hill at a pace of seven to ten miles an hour. In the middle of the route is the dreaded Bradford-street; but up this incline—in some places as much as a rise of 6 per cent.—the engine, with its car load, mounted at a pace of about five miles an hour. At this point the battery would be giving considerably over 100 amperes, and the motor exerting nearly its full power. The car arrived at Moseley, having accomplished its run, including stoppages, in about twenty-five minutes, without hitch or mishap of any kind.

The managing director of the Birmingham Central Tramways Company addressed a few remarks to the visitors explanatory of the company's policy in attempting the use of electric traction in preference to steam or cables. The first outlay had prohibited the use of the cable as well as the electric conductor system, besides the fact that if they failed at any one point the whole traffic would be put out of gear. Alluding to the use of a separate engine, he said that it might be possible that a smaller car, with self-contained motor and accumulators, would ultimately be used, but the expense of first experiment had decided them to try the separate locomotive, as this could be used together with their steam-cars. He had, moreover, the statement of Mr. Julien that they dared not face the problem with self-contained cars on this gradient to run the full day's work without recharging. If anyone could accomplish this, they were quite welcome to have a shot at it. They had adopted the present arrangement because it suited the condition of their rolling-stock, and with due regard to the actual commercial aspect of the undertaking. They had not undertaken the experiment without due caution, and wished to ascertain whether the use of electricity in the form of accumulators were applicable to their system, and whether in safety and certainty of working it would commend itself to the travelling public and to the authorities of Birmingham. The engineering difficulty was not the only one they had to encounter; an almost more important point was the satisfaction of the local authorities. The company wished to do all they could to comply with the requirements of the local authorities, but he hoped they would not require more than it was possible to supply, and would themselves also consider the requirements of the tramway company. He referred to the already-accomplished work of the Julien Company, and he wished to say that the very marked success of the present undertaking was due to the clever working out of the application of the system by Elwell-Parker, and particularly to Mr. Parker, who has placed the tramway world under great obligations by carrying out such a practical set of experiments. He thought it should also be recognised that the Birmingham Central Tramways Company are doing their best to accommodate the travelling public by the adoption of the latest developments of science. The result they had seen that day, of a full car of sixty passengers drawn by an electric engine, which would work for sixty miles, and run without trouble at an incline of 1 in 17, was one which he thought eminently satisfactory.

Councillor Lawley Parker said that it might be worth while to mention that the Corporation would certainly favourably regard the use of self-contained cars.

Mr. Parker referred to practical details of the working of the car, and stated that the return of power from the cells was 70 per cent. The charging took place at night, by a small engine now supplying power to the repair shop, which ran an Elwell-Parker dynamo.

It was understood that the cost of the locomotive was about £900, but the engine had not been bought by the tramway company. The company did not intend to commit themselves until it was satisfactorily proved practical commercially. A contract had been entered into with the Julien Company and Messrs. Elwell-Parker to run one car with this electric engine for three months at the price of 6d. per mile, the present price for steam running being about 8d.

At the conclusion of the trial the experiment was tried, with perfect success, of hauling one of the steam-engine cars (weighing thirteen tons) with its passenger car (four tons), which, with the electric car itself, weighing 8½ tons, made a load of over twenty-five tons, which was drawn without difficulty.

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SUNBEAM LAMPS.

The use of the high candle-power incandescent lamps made by the Sunbeam Lamp Company, of Gateshead-on-Tyne, is very much extending for use in situations where the powerful glare of the arc is not required, or to replace a group of a number of smaller incandescent lamps. It is often found that though they do not give an equal light per watt of electric energy, yet, being absolutely steady, and showing a light of a rich warm colour, nearly equal in all directions, their light gives an effective illumination to a greater distance than that of an arc lamp of the same "nominal" candle-power. An ordinary arc lamp usually, for public use, has to be shielded with an opal shade, and comparing the high power incandescent lamps with an arc lamp fitted with opal globe, using in both lamps the same current, the Sunbeam lamps will give almost two-thirds of the effective light of the arc. The light in the incandescent lamp, moreover, never suffers that painful flicker and momentary dullness that is so annoying to most persons, and, of course, there is never the slightest hissing sound. The colour, also, is very much preferable for interior lighting of public halls to that of an arc light.

As compared with clusters of small incandescent lamps, very great advantage is found in actual illumination for the same engine and dynamo power, while as regards cost of renewals the advantage is all on the side of the large lamp, which, even if it cost three times the price of a smaller lamp, will probably save the maintenance of ten or twenty of the latter. This advantage is the one which has mainly effected its introduction for the lighting large halls, hotel entrances, large warehouses, &c., where a powerful light is required. For unloading cargoes at night, these lights are coming greatly into favour, and a number of them are at present in use at Sir William Armstrong, Mitchell and Co.'s ship-yards, and other yards on the Tyne. The stations of the North British Railway at Glasgow and Edinburgh are also lighted by these lamps.

The lamps are made in various candle-powers, running from 200 up to 1,500 c.p., and are made for various voltages, usually running in the standard circuits of 50, 65, 80, and 100 volts.

We give herewith a table showing the current required for the various lamps. It will be seen that a current of eight amperes at 50 volts, which would suffice for an ordinary arc lamp, gives in these lamps 200 c.p. only, so that for extended lighting of open areas these lamps could never pretend to be so efficient as arcs, but its other advantages compensate for this loss in very many situations; and it is evident that their efficiency can be increased to almost any desired extent until the brilliance of an arc is attained, dependent only upon the extent to which the cost of renewal interferes with the higher efficiency.

CURRENT REQUIRED FOR SUNBEAM LAMPS.

High-Efficiency Lamps.

Candle Power.	Amperes at 50 volts.	Amperes at 65 volts.	Amperes at 80 volts.	Amperes at 100 volts.
100	—	—	—	—
150	6	—	—	—
200	8	6	—	—
300	12	9·5	8	6
400	15·5	12	10	8
500	—	15·5	12	10
600	—	—	15·5	12
800	—	—	20	15·5
1,000	—	—	25	20
1,200	—	—	30	25
1,500	—	—	—	30
	Longer Duration Lamps.			
100	5·5	—	—	—
150	7·5	5·5	—	—
200	10	7·5	5·5	5·5
300	15·5	11·5	9·5	7·5
400	—	15·5	12·5	10
500	—	—	15·5	12·5
600	—	—	—	15·5
800	—	—	—	20
1,000	—	—	—	25
1,200	—	—	—	—
1,500	—	—	—	—

Their efficiency, as compared to ordinary incandescent lamps is very high. Tested together with smaller lamps at the same incandescence, their life is considerably longer than the latter. On the other hand, if the ordinary average life is taken as data, they can be run at a higher temperature. On this basis their efficiency is nearly double that of ordinary lamps, and in lighting large areas this plan is adopted. In some cases, as for temporary lighting, or where more candle-power is required without increase of engine power and plant, the lamps are run at specially high candle-power and with greatly-increased efficiency, but, of course, with shorter life. The cost is very small as compared with a group of smaller lamps, and the increased light given in such a case will very soon pay for the greater need for renewal of the lamp. Calculations which have been made show that the saving in plant and outlay would be repaid if the lamp lasted only 150 hours, and anything over this will therefore be gain. The currents required in the different lamps are shown for high and low efficiency in the above table.

As regards ordinary length of life, we learn that one of these lamps of 500 c.p. has been running at the Brodringallt colliery, in the Rhondda Valley, since last November without attention and without requiring renewal. The Powell Duffryn Company have also made use of them at several of their collieries, with uniform success. Several of the large collieries in the counties of Durham, Northumberland, and Cumberland. In Wales they take the place of arc lights, and in particular they have been adopted by the Ebbw Vale Company, at their Victoria Iron Works, to replace the arc lamps previously used there. In February last three of the Sunbeam lamps were fixed in place of the like number of arc lamps, so as to work with the same current, which is furnished by Siemens' alternate current dynamo. These lamps worked so well that the Ebbw Vale Company recently decided to adopt them all through, as the light given was steadier and more cheerful than the light given by the arc lamp, and the avoidance of any necessity for cleaning the working parts, changing carbons, &c., was found a great saving in time and trouble. These lamps might evidently be tried with advantage by the railway companies for station work.

FACETIÆ.

HOW HE LIGHTED HIS CIGARETTE.—A young masher was being shown over the installation in the City, at the time of the old Metropolitan Brush Company, and while the engineer's back was turned the visitor rolled a cigarette, and tried to light it at an arc lamp. There was a slight "earth," and the current came down the moistened cigarette to that young man's molars, and he had sufficient toothache to last a good many lifetimes during the next minute or two.

AN ELECTRIC GLOW-WORM.—The tale comes to us of an enthusiastic entomologist who, walking down a main thoroughfare, thought he saw a chance to secure a beautiful specimen of glow-worm settled on an electric pole. He took out his handkerchief to entrap it, but, just on the point of capture, a policeman saw him and dragged him excitedly away. His life was saved. It was no glow-worm, but a minute arc from a defective wire fallen from the pole. The tale is vouched for by the learned *savant* himself, and so ought to be believed.

The Electric Light and Eyesight.—Prof. Chon, of Breslau, the eminent oculist, has recently touched upon the influence of electric lighting on the eyesight. He remarks that as diffused daylight is best for the eye, our artificial lighting should aim at a similar diffusion. Artificial light should not dazzle or flicker, and it should be abundant without heating the eye. Glow-lamps should never be looked at unless blurred by ground-glass shades, because of the intense concentration of light on the line of the filament. The electric light was, according to Prof. Chon, greatly to be preferred to any other for reading or writing by, if it be steady and abundant.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

OPEN SESAME.

For the first time in its history it may be said that the Grosvenor Gallery electric light installation was on Wednesday night open for public examination. It is not to be supposed, however, that those interested in the subject had not long ago formed a very good idea of how the work was carried on there, but whatever information had leaked out through various channels, or had been directly given to individuals, was supposed to be confidential, and we believe was so treated. Whether the managers were agreeably surprised at the general consensus of approval which met their action in inviting representatives of the technical and other papers to see their works at Deptford, and were thus induced to give as full a publicity to their work at the Grosvenor Gallery, is a question we cannot decide; but be this as it may, a few representative gentlemen were invited on Wednesday to examine the apparatus and arrangements as now existing at the Grosvenor Gallery. There may be another reason why such examination was permitted. It is hoped that within a few months the Deptford installation will be so far complete as to take up the running and to render further use of this smaller installation unnecessary, and so we have been permitted to hear the dying notes of this commercially successful, though hardly musical, swan.

It may be thought that what with Deptford and the Grosvenor Gallery we are making too much of the work which has been carried out at these places. Opinions, however, may well differ on this subject, and we venture to think that the majority of those engaged in the industry now and hereafter will look back upon the Grosvenor Gallery installation as the one ever green oasis standing boldly out in the midst of a dismal waste. Adverse criticisms have been common enough, yet against these there is the one statement which overwhelmingly disputes the conclusions of these critics, and that is from first to last there has been a constant accession of the number of lamps put upon the circuits till orders became so numerous that it was impossible to find power for any further increase.

The how it was done, is the history of overcoming successive difficulties. As development proceeded, weak points presented themselves and had to be remedied. Small pieces of apparatus gave place to larger ones, and crowded space was thus further utilised. However, the one constant cry has been "High potential with transformers." Since Mr. Ferranti has taken the management, we find the system thoroughly overhauled and perfected from beginning to end. His dynamo is supplemented by his transformer and meter, so that from the machine-room to the counting-house is plain sailing. The meter can be read just the same as a gas-meter, and is, we should say, less likely to get out of order. Another interesting

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feature of the experience gained at this installation, is to be found in the curves made daily of the current supplied. The current is taken every quarter of an hour, and from this table a curve is prepared, or rather a week's curves are made on the same sheet, and these daily and weekly curves are astonishingly similar. The slightest differences in demand are thus noted. The fog has its special curve, and even the rehearsals at the theatres play their part in altering the form. As we have so often pointed out, light supply, if it is not supplemented by power supply, means maximum demand upon the machinery for a comparatively short period of the day, hence the apparatus cannot be worked in its most economical fashion. We do not know whether Mr. Ferranti has a practical alternate current motor, but it is well worth the while of English makers to see if they cannot produce something at least equal to the Tesla or the Westinghouse-Tesla motor as designed in America. If our large installations are to be with alternate currents and transformers, then we sadly want the apparatus supplemented with a good motor to work with these currents. The attention of inventors has not really been directed to this desideratum, but though many of our leading engineers believe thoroughly in the use of direct currents and secondary batteries, others depend wholly and confidently for immediate success upon the transformer system. We have no doubt but that in the course of a few days full and ample description will be given of all that concerns the Grosvenor Gallery lighting. Men who a few years, and even months, ago were chary of investing capital in electrical enterprises, will gradually come round to the belief we have all along expressed, that in business hands, and out of the reach of speculative influences, a very large amount of capital can advantageously be used in the development of various electrical enterprises. The demand for capital is increasing. On all sides we hear of firms busy with orders booked well ahead; towns are enquiring for light; and it remains only for those who have the disposal of capital to notice the signs of the times, and judiciously invest when the opportunity offered is a legitimate one. To return to the Grosvenor installation. If Mr. Ferranti were a reciter—we believe he is a musician—he might well declaim with Tennyson:

Men, my brothers, men the workers, ever seeking something new,
That which they have done but earnest of the things that they shall do.

And if the one installation is but the earnest of the other, the general introduction of electric lighting and power distributed will at any rate not be long delayed, so far as London is concerned.

PAYING FOR HEALTH.—It is now an acknowledged fact that in paying for the electric light you are paying for health at the same time, and that every hour a man spends in a room lighted by gas tends to shorten his life and abridge his powers of work.—*R. E. Crompton.*

THE WARING CABLES.

The early history of the development of any great industry is always an interesting study. When railways superseded stage-coaches, it seemed absolutely impossible for railway-carriage builders to separate their ideas from the requirements of the old stage-coaches, and they continued for many years to build upon the same lines. Gradually, however, it was seen that the stage-coach design was not altogether suitable for railways, and we have in a later development, most luxurious, easy travelling carriages of a type quite distinct from any which existed in the early days. If we look at the electrical industry, and especially to electric lighting and transmission of power, we shall find that there has been a good deal said about insulation and insulating; but, for the most part, it has been taken for granted that the old method of insulation used for submarine cables would be that used in other work. This conservatism, if we may so term it, is no doubt a peculiarity which tends to retard progress, and it is only when someone attacks the problem, and gives a solution in an entirely different fashion, that progress is possible.

A number of attempts have been made to produce metallic circuits for electrical work which shall possess as few as possible of the properties which are detrimental to the work. Telephony, in the multiplication of wires which it necessitates, has given rise to troubles from induction, which various people, by means of what may be called multiple wire cables, have attempted to get rid of.

The requirements of the electric light industry are different from those of the telephonic industry, but still there are troubles arising from induction and from leakage, which it is very necessary to overcome. When David Brook proposed to put a thousand wires in a small pipe, he seemed to have commenced to work in a direction which would bear good fruit. There are only two systems of running circuits, overhead and underground. The overhead system presents fewer difficulties than the underground, but when the use of electrical energy becomes common—that is, when it is required in every house—the multiplication of the necessary wires overhead would be impossible; and we may say that in some shape or other electrical energy is destined to be carried to the major portion of the houses—at any rate in moderate-sized and large towns in all civilised countries—the distribution must, then, of necessity be underground. Unfortunately, the construction of our streets is such that in few instances has the forethought been taken to provide a permanent conduit under the sides of the street for what may be termed subterranean work. It would be cheaper in the long run to construct such permanent channels for the running of water and gas-pipes and electrical wires, but even with these subways it would be required to take into consideration the necessary insulation of such wires. Some years ago Messrs. Berthoud-Borel introduced their lead-sheathed insulated cable, and the production of the Waring Co. is upon these lines, but they use a different method of insulation. It may be pointed out here that the term anti-induction is hardly a satisfactory one; the induction is present, but what is meant is that the sting is taken out of it. Mr. Waring states that his insulation is a hydro-carbon compound, inorganic in its composition, and not liable to disintegration or deterioration. It is uniform throughout the length of a given conductor, but the range of resistance is from two hundred to one thousand megohms, according to the purpose for which the conductor is intended to be used. It is also an exceedingly refractory substance, and the temperature may be quite to the point of fusing the leaden casing of the cables, or the raising of the conductor to a white heat, without affecting the resistance of the insulation. We quote the company's statement with regard to this in the following sentences:

"Unlike paraffin, gutta-percha, and many other commonly used dielectrics, the Waring insulation may be subjected to a high degree of temperature without decentralising, carbonising, or breaking up into vapours and gases, but upon cooling returns to its normal condition, unimpaired in its insulating qualities. The cables of this system can

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TESTS OF WARING'S LEAD COVERED CABLES.

Taken by the Post Office Authorities on the 21st and 23rd April, 1888.

Distinctive number or letter.	Number of wires.	Diameter of conductor. Mils.	Diameter of conductor and insulation. Mils.	Diameter of cable inside leads. Mils.	Diameter outside lead. Mils.	Length tested. Miles.	Capacity in microfarads per mile. Minimum.	Maximum.	Average.	Insulation resistance per mile. Megohms.	Remarks.
A	3	49½	187	—	680	·268	·2835	·2870	·2846	1,402	Anti-induction cable.
B	52	31	89	—	900	·2005	·1950	·2150	·2010	68,770	Bunched.
C	6	64	148	700	850	·2	·3250*	·4100	·3860	2,544	Anti-induction.
D	7	50	172	750	830	·262	·1908	·2020	·1964	13,886	Bunched.
E	7	79	175	630	850	·2556	·2621	·2939	·2685	9,483	,,
F	7	40	130	413	547	·262	·2137	·2519	·2372	5,731	,,
G	1	80	—	218	339	·2516	—	—	·3938	2,097	Single.
H	1	51	—	179	312	·25	—	—	·2560	6,222	,,
J	1	39	—	203	320	·2489	—	—	·2089	12,444	,,
K	3	65	133	—	449	·1894	·3220	·4490	·3925	4,871	Bunched.
L	4	40	110	259	400	·2105	—	·4655	·4655	2,105	,,
M	4	45	113	280	460	·1894	·4223	·4329	·4278	6,313	,,
N	5	59	91	—	520	·1894	·3429*	·4545	·4198	1,254	Anti-induction.
I	1	314	—	528	750	·22725	—	—	·9198	—	Electric light stranded cable
O	1	400	—	520	750	·1894	—	—	1·0348	1,894	Electric light stranded cable

* Centre wire.

Temperature 56deg. F., but no correction could be applied, as the coefficient is at present unknown.

Cubic number.	Number of wires in cable.	Diameter of conductor. Mils.	Diameter of conductor and covering. Mils.	Diameter of entire cable outside lead. Mils.	Length of specimen. Miles.	Capacity per mile. Microfarads.	Insulation per mile. Megohms.	Temperature. Deg. F.	Remarks.
*1	6	64	157	875	·2	·3980	400·7	55	Lead between each wire.
†2	12 (5 outside)	64	135	1in.	·186	·3967	—	58	Lead between each outside wire.
†2	12 (7 inside)	52	98			·3263	—		No lead between inside wires.
*3	3	64	135	560	·2803	·4937	1711	56	Lead between wires.
‡4	19	40	67	517	·1894	·3752	732·2	55	No lead between wires.
§5	18	36	74	600	·1629	·3261	—	55	Lead between each three wires.
‡6	31	33	86	800	·2718	·2414	3000	55	No lead between wires.
7	1	32	134	293	·3788	·4666	378	55	
8	1	127	220	346	·5492	·7873	686	55	
9	1	80	165	309	·4943	·3650	8458	49	
9	—	—	—	—	—	—	5178	53	
9	—	—	—	—	—	·5437	29·07	140	
9	—	—	—	—	—	2·4280	·979	188	

* Anti-induction. † Combination. ‡ Bunched. § Anti-induction and bunched.

No. 7 shows higher capacity and lower insulation than No. 6, although No. 7 has a conductor of practically the same diameter covered with *thicker* insulation. This shows that the insulating material may fail to penetrate the cotton, except to a limited depth, producing the same effect as a thin covering.

therefore, with entire safety, be laid in close proximity to steam-pipes, either in buildings or in the thoroughfares. Thus excellently well insulated, in every respect meeting the requirements of science and experience, the conductors are closely encased in lead, to provide protection, strength, flexibility and durability, at the same time due regard being had to the quantity of encasing metal, in order to secure lightness and economical construction."

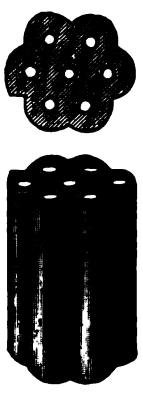

FIG. 1.

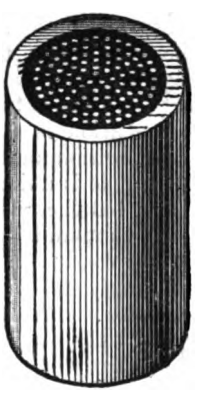

FIG. 2.

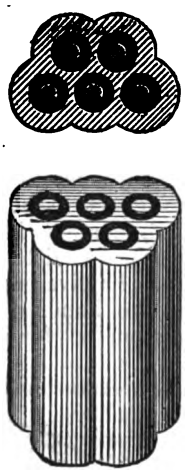

FIG. 3.

But, perhaps, the best proof that we can advance of the value of this system of insulation will be found in the tests taken by the Post Office authorities last year. These tests may be taken as authoritative, and as giving the character of the material used from a most unbiassed source (see tables above).

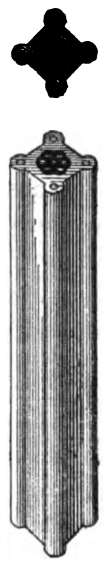

FIG. 5.

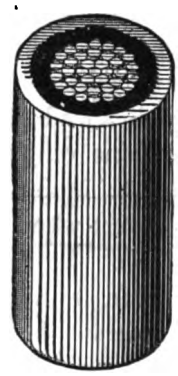

FIG. 4.

FIG. 6.

We may, however, add to this the report of Sir William Thompson, given in June, 1888. This report states:

"As a general conclusion, from the extensive and searching tests of the Waring cables which I have made in my laboratory since the first specimens were sent to me about four months ago, I am of opinion that they are well suited

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for all underground telegraphic and telephonic work and for underground electric light conductors; also for conductors carried through buildings or tunnels, and in close proximity to large steam-pipes, or along walls out of doors in a great variety of circumstances.

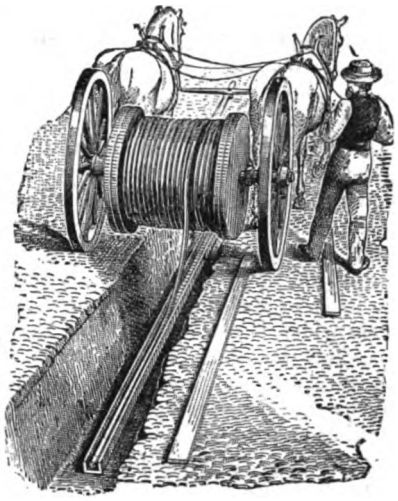


FIG. 7.

"The insulating materials, and the mode of their application, are such that, however high their temperature, the conductor can never become displaced from its proper position in the axis of the containing tube. It may be heated up to anything under the melting temperature of lead, and kept hot for a considerable time (for any time, I believe) without permanent damage. The insulation—as in the case of all other known insulating material—is greatly diminished by elevation of temperature, but, unlike others, its usefulness as an insulator is not destroyed by high temperature, and when brought back to any ordinary condition of temperature, it returns fully to its normal insulating value without deterioration of any kind.

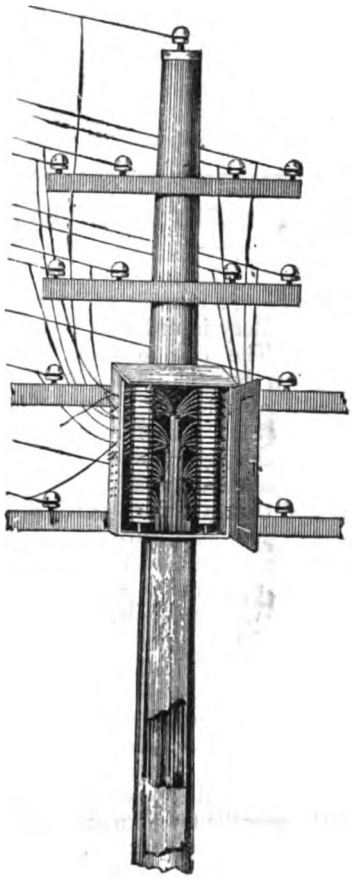
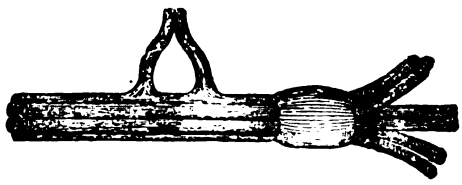


FIG. 10.

"The numerous testimonials of a thoroughly definite character by well-known competent electricians and engineers contained in the published descriptive pamphlet show conclusively that in a large variety of work, extending over several years of use, the Waring cables have given perfectly satisfactory results. The insulation in each case referred to has remained perfect, and has shown no sign of deterioration.

"It is with pleasure that I add my testimony to the great value of these cables."

FIG. 8.



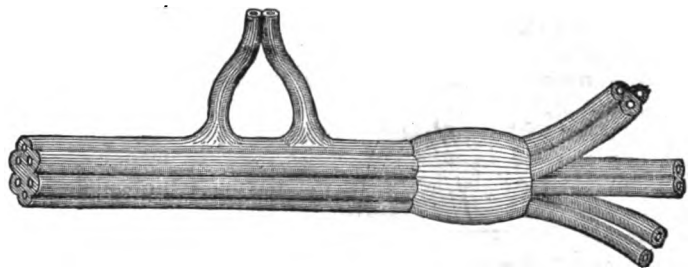
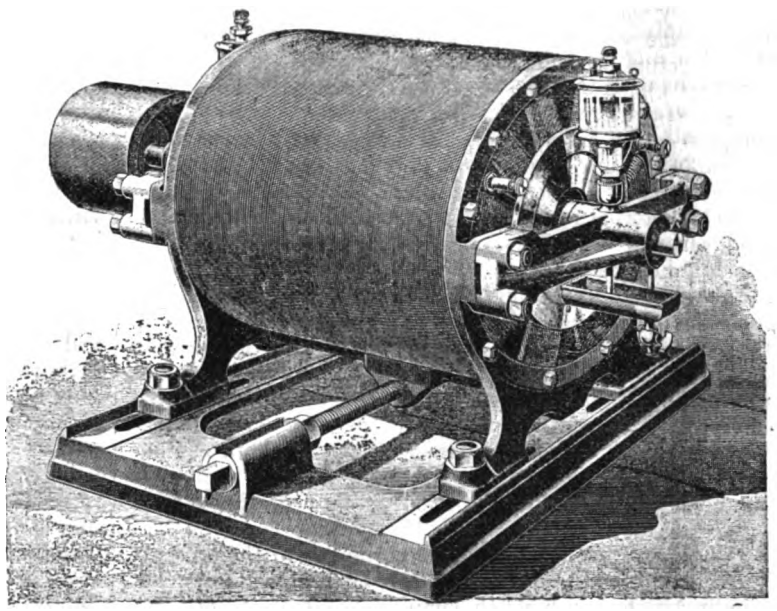


FIG. 9.

It may be interesting to show various forms in which the cable is manufactured, and how it is used in America. The company, whose offices are at 85, Queen-street, E.C., is, we believe, rapidly making arrangements for the production of a cable in this country. Fig. 1 shows anti-induction cable with seven wires. It is needless to state that similar cables can be had containing different numbers of wires. Then, where a very large number of wires are required in a small space, and especially, we should say, for telephonic purposes, they are made as shown in Fig. 2. For electric light work Fig. 3 and Fig. 4 are specimens of solid and stranded conductors, while Fig. 5 shows one intended for submarine cable work. It may be interesting to give at greater length the manner of making the joints. Of course, the cable can be made to any length, and the lengths are united by a simple joint. The cable joints are first stripped off the lead, the insulation removed, and the wires substantially joined and soldered. Each wire joint is then wrapped with the Waring insulated tape, and this served, with strips of lead, to preserve the metallic continuity of the casing. A sleeve of lead pipe, previously slipped over one of the ends, is then brought up over the joint, both ends dressed to fit the cable, and solder-wiped joints, made as shown in Fig. 6. The sleeve being tapped near the centre, is then filled with insulation and closed. Where there is likelihood of a tensile strain in laying the cable, as in deep water, after reaching the point



The Westinghouse-Tesla Motor. (For details see next page.)

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of placing on the sleeve, as above described, the connection is made by a single solid wipe-joint.

Fig. 7 shows the method adopted in laying a cable that is for underground work. A trench is dug about two feet deep, keeping aloof from gas and water pipes. An open trough or box is laid in the bottom, and a reel of cable, with an axle swung through its centre, mounted on wheels, is drawn along, paying off the cable into the box or duct as it moves.

The cover of the box or duct being fastened, the ditch is filled up and the street repaved. Each step of the operation promptly following in its proper order, the thoroughfares are kept open only a short time at any given place, thus causing the least, if any, obstruction to travel. Where closed conduits are used, the cable can be drawn through the spaces in the ordinary manner.

The methods of looping, branching, and spreading the Waring anti-induction cables are represented in Figs. 8 and 9.

The ease with which any particular conductor can be reached and led in other directions from the main cable, without severing the latter or disturbing the remaining conductors, is shown. The sharp or square edge, formed on one of the ribs, designates a conductor, by counting to the right or left of which any desired conductor can be selected without disturbing the others.

For overhead lines the Waring cables, supported by hangers on steel wires strung to poles, are not only an entirely satisfactory substitute, but have proven vastly superior to the ordinary air line; and even where the latter have been connected to short lengths of Waring anti-induction cables, these cables have been found to diminish induction throughout the entire circuit thus formed.

Fig. 10 shows cable-box on a junction pole, showing connection from Waring underground cables to air lines, as adopted by the New York Fire Department.

WESTINGHOUSE TESLA MOTOR.

Our American contemporaries, in their issue of October 27, have described the Westinghouse system and factory. The Westinghouse Company controls a number of very valuable patents, and, as is well known, promises to be one of the most successful companies in the States. We hear that from time to time it is their intention to turn their attention towards developing a business in England. Whether this is the case or not the future will decide. One of the most interesting pieces of apparatus controlled by the company is the Tesla motor. We quote the remarks made by our New York contemporary, the *Electrical Review*, on this machine:

"The alternating current motor consists of a series of field-magnets, wound with two sets of coils, the ends of which are connected to binding posts conveniently located for attachment to the supply circuit. These binding posts form the only connection with the current, which current is taken from the regular lighting circuits, with the addition of a single return wire. This return wire makes it possible to send two alternating currents through the field of the motor at the same time, the pulsations of the two currents being similar, but not simultaneous. The resultant of these two currents is that a rapidly rotating polarity is given to the field, corresponding in period to that of the current producing it.

"The armature is in appearance similar to the ordinary Siemens drum armature, without the commutator. The winding is, however, much simpler, and consists of a few turns of comparatively small wire, the ends of which, instead of being carried out to a collecting ring, or any other form of sliding contact, are soldered together, forming a closed circuit, having no connection with the energising current. The alternating currents in the field induce secondary currents in the armature, and by the attraction between these and the revolving polarity of the field rotation is produced, the rate of rotation corresponding very nearly with that of the field.

"When no work is being done by the motor, the synchronism is exact or nearly so, and very little current passes either through the armature or field, but as load is put on and the work increases, the armature tends to lag slightly, causing the passage of more current in proportion to the work done. The reaction between the armature and the field is similar to that between the primary and secondary coils of a converter, and the increase of load on the motor causes increased supply of current in a manner exactly as takes place when lamps are added to the secondary circuit of a converter. The addition of the return wire for the motor circuit can be made easily so as to adapt existing lighting circuits to motor work, and the armature of the dynamo used for driving motors is equally available for lighting purposes.

"By an ingenious adaptation of the converter principle, this motor may be regulated in speed and reversed in its direction of motion without the use of switches or resistance coil. The method of operation is exactly similar to the link reversing gear of a locomotive. The extreme position of the reversing lever in one direction corresponds to full speed ahead, from which it can be graduated through every shade of intermediate speed to the reversing point, and from that on to full speed backwards. This is more readily accomplished owing to the absence of brushes, since there can be no sparking or wear due to the passage of current under any circumstances. No attention need be given to the motor beyond the filling and cleaning of the oil cups.

"The alternating motor is more compact than the direct current motor, and lighter in proportion to the power delivered. It can be served either through a converter or directly from the primary circuits. The connections may be so protected that no inconvenience or danger can possibly result from direct connection to high-tension service, should such become desirable. As there are no sliding contacts, and the binding posts need never be touched, or even exposed in any way, the use of a high-tension current becomes possible. The extreme simplicity of the winding, and general construction of this motor, makes it very unlikely to get out of repair. The insulation of the armature is of no importance, since the current traversing it is never but a few volts, and often less than one volt, regardless of the voltage of the supplying circuits. Absolutely no electrical knowledge is required in its operation, and the connections to the circuit are so simple that anyone of ordinary intelligence can make them with ease and certainty. The alternating current motor is therefore thoroughly practical for manufacturing, commercial, and domestic use in the hands of servants."

THE GROSVENOR GALLERY INSTALLATION.—I.

On Wednesday night, at the invitation of the London Electric Supply Corporation, a number of "scientific guests" visited the Grosvenor Gallery in order to inspect the lighting machinery there. The cue to start upon the visit of inspection was given by the Hon. R. Brougham at 11.30 p.m., whose call to time was quickly responded to, and the party, headed by Sir Coutts Lindsay, Major Waller, and Mr. de Ferranti, made their way into regions that savoured somewhat of pandemonium. Talk about machinery on board ship, and that a man-of-war is a perfect box of engines. This stoke-hole of a warship is not to be compared with the stoke-hole of the Grosvenor Gallery. Space is limited, but limited or not, enough steam has to be generated in the Babcock-Wilcox boilers to supply four Marshall engines, and a Corliss engine by Hick-Hargreaves. The four Marshall engines are driven to give collectively from 800 to 1,000 h.p., and the Corliss engine to give 700 h.p., making a total of from 1,500 to 1,800 h.p. When we say that these Marshall engines are being driven to nearly twice what ought to be their normal capacity, and that without difficulty, it will be seen that a good deal may be said about the excellent workmanship and material put into these engines. We are not referring to nominal horse-power in saying this, but reckoning that the normal horse-power should be from two and a half to three times the nominal. We give herewith a rough diagram of the method of disposing the apparatus in the machine-room. The great Corliss engine takes the centre position, and drives a Ferranti dynamo by means of rope gearing. These dynamos are, as is well known, alternate

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current dynamos, and intended to provide current for 18,000 16-c.p. incandescent lamps at 275 revolutions. The weight of dynamo, including bed-plate, is about thirty-five tons. Besides these dynamos and their exciters, the latter of which are made by Siemens, there is a Kapp dynamo, driven direct by an Allen engine. This dynamo is not shown in the plan, but fills a spare corner just at the entrance of the machine-room. On one side of the Corliss engine are two single Marshall engines, and on the other side one coupled Marshall. The width of the pulleys on the single Marshalls is 2ft., that on the coupled Marshall, 31in. The width of the rope pulley on the Corliss is 47in., and its diameter 13ft. The Marshalls all connect to a shaft, portions, or the whole, of which can be thrown into gear by the clutches, C. The number of revolutions of engines is 80 throughout. Two or three exceedingly interesting experiments were shown to the visitors, such as the switching off the alternate and switching on the direct current, with hardly a blink in the lamps. But perhaps the most interesting were seen in another room, which might be termed an experimental room. Here were 100 incandescent 100-volt lamps in series, and these were lighted by a current through an experimental transformers, some of the visitors thus seeing for the first time work under a minimum of 10,000 volts, and a maximum of, perhaps, 25,000 volts. Then was shown the effect of this pressure upon points separated

It is true that machinery is used in welding, but it is merely devoted to the application of power to supplement the limits of human strength, and with trip hammer and crane the same skill is necessary as with hammer and anvil.

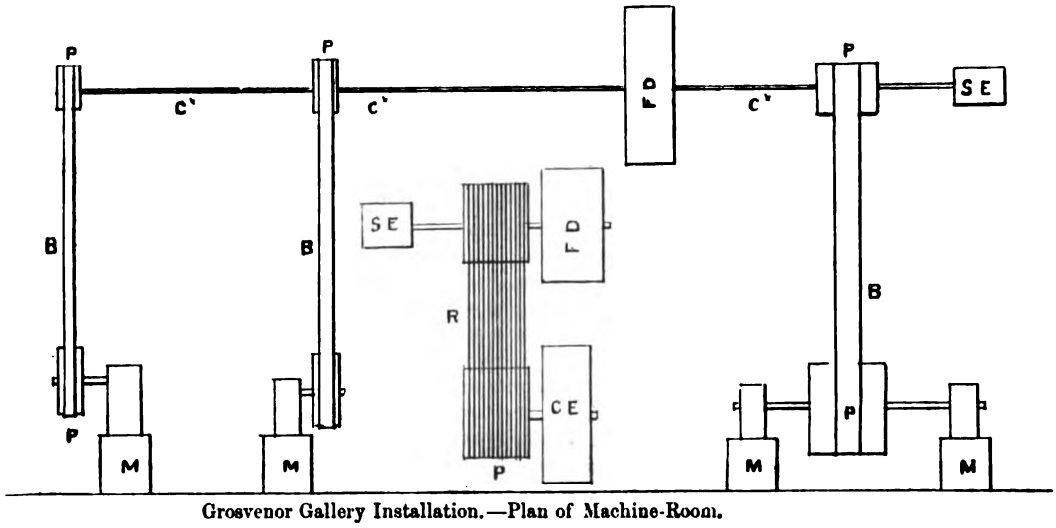
Since the first of the year there has been a commercial application of electric welding, the invention of Prof. Elihu Thomson, which has already reached a degree of importance sufficient to render it a live issue in every branch of manufacture to which it has been shown to be applicable.

This process is a new art, for, unlike the smith who is confined to iron, steel and platinum, it can weld any two pieces of the same metal or alloy ranging from the most refractory metals to the alloy which fuses at 162deg. Fahr. It will join dissimilar metals when the welding point of one is not too far in excess of the fusion point of the other.

These results seem to indicate that the classification of metals into welding and non-welding has been due to imperfections in the ordinary and time-honoured methods, rather than any peculiarity in physical constitution warranting such arbitrary classification.

It is true that some of the metals have been joined without solder by means of the autogenous soldering process, wherein local fusion is produced with an oxyhydrogen blowpipe, but the laboratory experiment is not a union of metals heated to a plastic condition which precedes fusion, according to the accepted meaning of welding.

B belt.
P pulley.
M Marshall engine.
F D Ferranti dynamo.
C Clutch.
S E Siemen's exciter.
R Rope gearing.
C E Corliss engine.



Grosvenor Gallery Installation.—Plan of Machine-Room.

by an air space of from ·5 to ·75in., and the fusing of a tin cut-out. If we say no more upon these subjects at present it must be taken to be because the time and space at our disposal at this period of the week is somewhat limited. There are a number of details and accessories in this installation to which it will be desirable to refer, and which will form the subject of another article. Meanwhile it is necessary to emphasise that under considerable difficulties as regards space and the action of neighbours, a successful installation has been developed in the heart of London, which has taught customers that the light can be relied upon, and the providers that its supply can be made commercially profitable.

ELECTRIC WELDING.*

BY C. J. H. WOODBURY.

The smith is the highest type of handicraftsman; he alone of all artisans making his own tools, and also those of others, commands the dependence of all upon his offices. His work is prehistoric, reaching beyond records or traditions, and known to have existed in still earlier times through the personifications of mythology, wherein Vulcan was essential to other divinities. The blacksmith is a factor in every stage of the history of mankind, and his work is now, and always has been, a matter of individual skill, depending upon a keen eye and steady hand, with a fine sense of form and dimension, untouched by the flood of invention, which has modified, or even recast, other methods of production.

* Paper read before the American Association of Mechanical Engineers, Scranton, Pa.

Passing by the scientific interest of electric welding, a short allusion will be made to the principles upon which it is based as preliminary to a description of the apparatus, and then consideration will be given to its practical applications.

The Principles

All forms of matter possess in varying degree the susceptibility of permitting the molecular motion necessary for the transfer of electric energy; those whose characteristics are favourable for such motion being termed conductors, and those which do not readily permit such motions are called non-conductors or insulators; and various adjectives are frequently used to express in a general way some sense of their value, but throughout the whole list of all known matter there is some measure of conductivity, and the whole expression amounts to one of degree; the conductivity of silver, for example, being over one hundred billion times that of glass; and other materials possess measures of conductivity lying between these extremes. The ability of anybody to conduct electricity in comparison with others of its kind is directly as the area of the cross section and inversely as the length.

Whenever electricity is provided with what is termed a good conductor, it makes no manifestation of its presence, but if there is poor conductivity by reason of small cross section or poor conductivity of the material, there is resistance to the electricity. Then a portion of the electric energy is expended in producing excessive molecular motion, and converted into heat, which is radiant if the temperature is high enough, as in the case of the incandescent light, when the metal portion of the circuit possesses ample conductivity to carry the electricity without appreci

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able heating, but the carbon filament in the lamp is a poor conductor, both in regard to physical characteristics of the material and small cross section, and the molecular motion is so violent as to produce a temperature sufficiently great to contain light rays.

The total amount of mechanical work done by a current, C, in overcoming a resistance, R, during a time, T, is $R C^2 T$; and the equivalent amount of heat is obtained by dividing the expression by J, the mechanical equivalent of heat.

$$H = \frac{R C^2 T}{J}.$$

In an induction coil, electricity of large current and low pressure is converted into an equivalent electrical energy of small current and high pressure by means of a bar of soft iron, or a bundle of wires, wrapped with two coils of insulated wire of different lengths and diameters. An alternating current being sent through the shorter wire, alternately magnetises and demagnetises the iron bar with reversed magnetic polarity, and reversals of magnetism in this bar in turn produce an alternating current in the circuit of which the secondary coil is a portion; the secondary current being, as stated above, of high potential and small quantity.

By suitable structural changes, an induction coil can be inverted as to its functions, and used to convert small electric currents into large ones, with inverse changes in potential.

The Apparatus.

The electricity is generated by one of two methods. In the direct system, the dynamo is contained in the machine below the clamps, and the armature contains two windings; the one being a fine winding which is in series with the field magnetic coils, and the other winding being merely a bar of copper in the form of a letter U or less than a single coil. This bar being of very low resistance, the maximum current is sufficient for welding purposes, and the terminals are connected directly to the copper clamps. Alternating currents are generated in this machine, and used for welding, in order to avoid commutators, which are necessary in direct current machines. It should be remembered that in all dynamos the electricity is generated in alternating currents, and that these currents are in proper turn fed to brushes of opposite polarity, and thus rendered continuous. In an alternating current dynamo the electricity is conducted from the armature to rings, instead of to a commutator, and is thus better suited for large currents, and some forms of the apparatus do not require rings or any moving contacts. There is no electrical reason why an alternating current should be used except the convenience of its manipulation. In fact, the continuous current supplied by secondary batteries has been used for this purpose.

Another form of apparatus, termed the indirect system, is more conveniently suited for large work, or in places where a number of welding machines are operated by the current from a single dynamo. The welding current is produced by conversion of the comparatively high tension current by means of an inverted induction coil, termed a transformer. The primary circuit from the dynamo is conducted through many turns of fine wire wound round a soft iron ring, and upon this same ring is a single turn of a large copper bar, in which the welding current is produced by an inductive effect. These currents receive 4,000 to 15,000 alternations per minute. The welding currents are not changed suddenly or by switches, as such manipulation would not be desirable or even practicable with the great currents used; but in the direct welding machine a set of resistance coils is placed in the fine circuit which passes around the field-magnets, and by interposing more or less of the resistance coils in this circuit the strength of the magnets is diminished or increased, and the welding current altered accordingly.

With the indirect machine, the amount of the secondary or welding current is controlled by varying the current in the primary coil by means of a kicking coil, or by a variable shunt to the field-coils and in other ways.

In either case the apparatus is simple and in full and complete control at will of the operator by movement of a lever, and this action controls the heat.

The Process.

In the electric welding process, the two pieces to be joined are secured in firm end contact by a pair of adjustable copper clamps, which are placed upon the top of the apparatus. An electric current of large volume is passed through the pieces, and the contact between them being of less conductivity than the homogeneous metal, heating ensues at this place, as the juncture is brought to the proper temperature by the gradual motion of the regulating lever, and as the metal softens, the clamps are pressed towards each other to insure a continuous metallic union across the bar.

The weld begins at the centre and proceeds radially towards the surface as the temperature becomes greater than at the interior. The heating is further increased by the fact that the resistance of the hot metal is greater than that of cold metal.

The enormous electric currents used in this welding process sometimes reach 50,000 amperes, but with an E.M.F. of half a volt, and, therefore, not capable of giving any sensation to a person.

It would be injudicious to offer any premium upon ignorance, but the operation of electric welding is one of the simplest mechanical processes, requiring but little skill on the part of the operator in comparison with that exact training of hand and eye, and long experience necessary for ordinary welding. The operator must understand the colour of the proper welding heat of the metal under treatment, but this is readily learned. The work is not manipulated during the process, except when it is desired to reduce the burr at the weld, and is at all times under observation, and its heat subject to entire control by means of a lever which graduates the strength of the current.

The dynamo generating the electricity is self-regulating, and requires no attention except for lubrication.

There is no unnecessary waste of fuel, the heating being local, and does not extend far from the weld: cotton-covered wire, one-fourth of an inch in diameter, can be welded without searing the insulation over three-fourths of an inch from the weld.

The time for making a weld varies from a fraction of a second to about two minutes, according to the work; although nothing over 2in. diameter has yet been welded, but larger machines are in process of construction.

It is not necessary to provide motive power fully equal to the maximum demand, as the time is so short that the momentum of a fly-wheel will serve the same purpose as in a drop press, and give up the surplus energy required.

The power is inversely proportional to the time, and appears to be about proportional to the 2·3 power of the diameter in inches, with a slight variation in favour of quick work caused by differences in rates of thermal conductivity of the material.

Applications.

The process is far cheaper than that of hand welding, and also extends to other methods of manufacture, but the comparative expense differs according to the previous conditions in every place where it has been applied thus far.

Its applications in practical work thus far have been confined to butt welding for many purposes, such as continuous wire work, carriage work, axles, and tires, cotton bale ties, barrel hoops, and wire cables, and many miscellaneous purposes. Axes are made of drop forgings, joining the tool steel edge to a mild steel poll, bars are heated in the middle and upset forming collars, and pipes are joined together—a matter of great value in ice machines. The list might be continued to greater length, but this indicates the range of its practical uses at this early day.

Strength of Electric Welds

The value of the process, for most purposes, independent from any scientific interest or mechanical ingenuity shown in the apparatus, must be that of the resistance of the welds under tensile stress.

It will be readily understood, however, that, as this process accomplishes many things hitherto impossible, aside from any question of ultimate strength, it is fitted for applications in many constructions where it saves labour and time; provided only that the joints be in all cases suffi-

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ciently good for the purpose for which the article is designed. A large field thus opens up in the execution of ornamental design in metal work, where it will supplant screws, rivets, or solder for fastenings, and in other evident applications.

There is no reason why such a weld should be stronger than the rest of the bar, but if averaging of equal strength some of the breaks would occur at the weld. There have been many tests made on various testing machines, but it has been considered preferable to submit only the official record of tests made on the Emery Testing Machine at the U.S. arsenal at Watertown, Mass.

OVERHEAD AND UNDERGROUND WIRES IN NEW YORK.*

BY DR. SCHUYLER S. WHEELER.

(*Concluded from page 353.*)

The man-holes used in connection with these various kinds of ducts have nearly all been built of brick laid in hydraulic cement, and capped with an iron casting to form a seat for the water-tight lid. The lids are bolted down upon a rubber gasket; but, unlike the Edison lids—held by several screws—they are secured by a single thrusting screw, which, passing through a cross-bar, presses down upon the centre of the cover. Some of the lids have been made funnel-shaped, so as to cause water to drain away from the edge and collect in the centre. By this means the liability to leakage at the gasket is diminished, because there is less chance of water standing over the joint. The facility of opening the man-holes afforded by this method of fastening the lid with a single screw is of great value in reducing the labour and time required to open and close a line of conduit when laying a wire, and is a material advance in the solution of the problem.

In regard to moisture in the conduits: in the iron tube plan, which is the best, there is, of course, no leakage, because the tubes themselves are water-tight—could even be made air-tight—and because they are covered with cement which is in itself water-tight. The man-holes are made of water-tight materials, and there should be no leakage under the lid. Lookers-on find that a great many of the man-holes have a great deal of water standing in them; this is simply because the lids are not fastened down, but simply laid in place by the builders, often without any gasket, and the man-holes fill with rain and stay full until cleaned out for use. When cleaned and closed properly, they appear not to receive any water by leakage. To satisfy myself of this, I had an ordinary brick man-hole, which had been thoroughly cleaned and dried by letting the sunshine in on a bright day, marked on the inside with lime all the way round under the cover and then closed. This marking was to show whether any water came through the joint of the cover, in which case it would have run down over the lime mark and discoloured it, or whether it soaked in through the bottom or sides. But after a rainfall sufficiently heavy to test the leakage, the hole was opened and found perfectly dry and the lime undisturbed. This proved that there was leakage neither through the brickwork nor under the cover.

There is, however, another source of moisture, difficult to overcome—viz., the condensation of vapour from the air which the man-hole and ducts contain. Every time a hole is opened, it refills itself with warm air, containing more moisture than it can keep when cooled down to the temperature of the masonry; consequently as soon as the lid is screwed down, this fresh air deposits a dew on the inside of the man-hole. As it is impossible to open and dry out a man-hole without letting in new air which will condense in turn, no amount of cleaning will overcome this difficulty. The presence of moisture tends to corrode exposed wires; and, therefore, the question of whether it is better to protect the splices and make the insulation of the wires so that they will not be injured by this moisture, or to dry out the entire system of conduits by a system of ventilation, is unsettled. But this question fortunately is one of minor importance.

* Abstract of paper to National Electric Light Association.

The question of distribution of electrical currents from the main subways constructed in the manner I have described, has been largely left by the authorities in the city of New York to the preference of the electrical companies.

Two systems of distribution are at present actually in use in New York by the Telephone Company. These are known as the house-top system of distribution, an example of which may be seen at Sixth-avenue and Fifty-first-street, and the hand-hole system of distribution, which may be seen at Broadway and Exchange-place.

In addition to these systems, there are five modes of distribution which can be readily applied to the subways as constructed in New York, and which will be allowed in cases where they are severally most expedient—the lamp-post system of distribution, the house-front system, the house-vault system, now in use in Chicago, the back-yard system, and the man-hole system. In the heart of Chicago the distribution question is peculiarly easy of solution, because the side-walks were left hollow by raising the street levels after the great fire, and the wires are run through these spaces to the houses.

Having decided the question of the kind of conduit to use, the commission proceeded to have subways constructed accordingly at once. It was decided best, as a matter of expediency, and to prevent accident, that electric light subways should be distinct from those intended for telephone and telegraph service, and it has therefore been the practice of the authorities in New York to build subways for one class of conductors upon one side of the street and reserve the other side for the other class.

The telephone people were the first to realise that underground wires were sure to be ultimately a success. Their business had grown enormously They had about reached the capacity of their poles' lines, and it was not easy to get the use of additional streets, because the streets were crowded with wires—both their own and those of other companies. It was found that the growth of the telephone business was practically put an end to by the fact that no more room could be found in which to string wires. House owners were charging a rental of 1dol. per wire per year, which, in some cases, amounted to a very large rental for a single building, and the telephone people had reached the point of refusing subscribers. They then came forward, and were the first to declare for underground wires.

After some resistance, the telegraph and electric light companies have come to the conclusion that it is as well for them to comply with the demands of the public and place the bulk of their conductors underground. And, as a matter of fact, in the city of New York to-day there is but one single company out of the large number doing business here which refuses absolutely to comply with the provisions of the Subway Acts, and nine-tenths of the opposition and outcry has been caused by that company.

At the present time the total construction of single ducts in the city of New York amounts to 420 miles. In these subways, there are already in operation some 4,000 miles of telephone and telegraph wires, and some hundreds of miles of incandescent electric light conductors. Cables for arc lighting are to be drawn in on Broadway from Fourteenth to Thirty-fourth streets, by the Brush Electric Lighting Co. within the present week. A letter from the electrician of the Metropolitan Telephone and Telegraph Company, bearing date August 25, as estimating the length of cables of various kinds now underground, is as follows:

"New York, August 25, 1888.

"S. S, Wheeler, Esq.,
"Electrician of the Board of Electrical Control.

"Dear Sir,—I have hastily collected the following information relating to the underground mileage of wire:

"The number of miles of single wire conductors in New York city of the various kinds is as follows:

Brooks' system, laid May 28, 1885	200	miles
Patterson cable, laid March 18, 1885	226	„
Edison system, laid June 20, 1885	194	„
Patterson, laid in 1886-87.....	805	„
Patterson cable, twisted in pairs, number of miles counting both wires, in 1888	2,272	„

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"We have in course of construction some 12,000 miles of conductors, which will be laid in September and October.

"Total number of miles already laid in New York, 3,697.

"The number of miles of underground wire in Brooklyn is 2,100. The number of miles of underground wire in Paris is 4,100. The number of miles of underground wire in Chicago is 200.

"As per report of telephone convention held September 26, 1887.

"The number of miles of underground wire in Boston is 400. The number of miles of underground wire in Pittsburgh is about 1,000.

"I find that there is a very small amount of underground wires used in London for telephone purposes, there being some short lengths used entering exchanges, which is not worth while considering.—Respectfully,

"(Signed) J. A. SEELY, Electrician."

It will be seen from this that there are already underground, in the city of New York, more electrical conductors than in any other city in the world (except Paris), while the capacity of the construction already finished in this city may be estimated fairly at something over 30,000 miles of conductors.

There are through lines completed from the Battery to the Park on the two principal thoroughfares of this city, Broadway and Sixth-avenue, and a gradual conversion of overhead lines to underground lines in the busy parts of the city may be confidently expected.

The board of electrical control is not unmindful, however, of the magnitude of the labour and expense required in converting the present arrangements into underground systems, and does not contemplate either the hampering of the business of electrical companies by forcing unreasonable numbers of wires underground, or by attempting to compel the use of subways faster than is consistent with the efficiency of the various electric service to the public. If the great mass of overhead conductors are removed, and the remainder of the service brought to a condition which will insure the safety of the public, and, at the same time, the benefit of the companies themselves, it will be the result desired by the people of the city, and which the board of electrical control is endeavouring to attain.

As to this matter of regulating the overhead service in the city, I may say that an investigation of all the wires overhead, instituted since I have been connected with the work of the authorities in charge of electrical matters here, by the inspectors appointed after a rigid examination found competent for the purpose, has shown that a great deal of very bad and unnecessarily dangerous work has been done in New York, and that a reprehensible and inexcusable condition of overhead wires is the principal, if not the only, cause of the clamour for underground service.

In addition to this, an enormous quantity of wire and a large number of poles not in use at all exist, amounting, as has been variously estimated, to from a half to two-thirds of all the wire and poles in the city.

As I have said, a system of inspection and reports has been organised, and within a few months there have been found and reported to the owners 2,000 dead wires and other objectionable things described in the enclosed schedule, which explains itself. A notice is sent out in every case; at the end of a week the work is again inspected, and if nothing has been done the owner is again notified, and if the wires, poles, &c., are not necessary, a notice is also sent to the Bureau of Encumbrances of the Department of Public Works to remove them.

All arc lamps that are so low as to be within the reach of a pedestrian with an umbrella are reported as too low. Circuits which have especially defective insulation or joints are reported as dangerous. A few cases of bad indoor work have been reported as violating the rules of the board of fire underwriters, and so on. The number of complaints sent to the various companies, as well as the proportion of them that receive attention by each company, are shown in the detailed schedule, which indicates the position taken toward the work of inspection by the several companies, and I may say that the contumacious company, of which I have already spoken, is the only one which disregards the notification of flagrant bad work, for which there is no excuse, and which everyone else admits should be inspected on behalf of the public and corrected immediately.

One has no idea of the aërial freebooting that is and always has been going on with overhead wires, until he spends some time seeing what there is overhead. The condition of wires in this city is simply outrageous. Every other kind of business, such as those which involve obstructing the side-walks, have fallen under the supervision of some branch of the Government, and cleanliness and order have been insisted upon; but heretofore there has never been any supervision of outdoor wiring, and its condition corresponds to that of a city without police supervision.

The companies owning wires will not permit each other to make common use of the poles, but will chop off wires owned by others without notice. The telephone people object to the electric light wires on account of the induction. Where there is a line of light wires on their side of the street passing close to their poles they will not allow them to be made fast. The result of the necessity thus made for extra poles is sometimes four lines of poles on one side of the street, hence most of the wires swing close to or against the other poles to which they are not attached, and linemen in climbing them have to crawl through all the other wires which are not fastened to cross-arms.

Among the cases of dangerous wires and unnecessary obstructions found by the inspectors are full lines of large poles extending over miles of streets, filled with wires which are "open" and out of use, but left standing to save the expense of removal; long lines of poles left standing to preserve right of way; arc light day circuits within reach and with the insulation dropping off, and bunches of dead wires hanging from house tops, &c.

All of the work of inspection done by this department is such as is necessary for improving the condition of overhead electrical work and removing fixtures, &c., that are absolutely dangerous and objectionable.

For the purpose of the various legal proceedings which are being carried on to compel the most objectionable arc light company to make a start in placing their wires underground, the other principal companies having proceeded voluntarily, the pole line on Twenty-fifth-street from Broadway to Fifth-avenue was chosen for special complaint. The subways on this route, which were specially provided for these lines, have been finished for some time, and are dry and in good order. This line of overhead wires is in bad order, one of its stretches having no less than thirteen splices; and it is made still more liable to do damage by the presence of numerous dead wires which, not being required for use, are practically stored upon the cross-arms.

ON OCEAN TEMPERATURES IN RELATION TO SUBMARINE CABLES.*

BY WM. LANT CARPENTER, B.A., B.SC., MEMBER.

In the paper read by Mr. Stallibrass on November 10, 1887, on "Deep Sea Soundings in connection with Submarine Telegraphy," and in the discussion thereon, no reference was made to temperature sounding and the influence of temperature upon (1) the conductor, (2) the insulation resistance of cables. Ocean temperatures varied, even in the tropics, from 85deg. F. to 30deg. F. The resistance of a conductor at 85deg. was 10·8 per cent. greater than at 30deg.; but the insulation resistance of a cable at 30deg. was thirty times that at 85deg. Calculations and diagrams to show this, founded on data obtained from the Accra-Sierra Leone cable, laid in 1886, and kindly supplied to the author by Mr. Henry D. Wilkinson (member), were exhibited. All insulating substances were not equally thus affected. The influence of pressure upon insulation resistance was touched on in passing, and the author went on to describe the method of ascertaining temperatures at great depths in the sea. Ordinary self-registering thermometers indicated too high a temperature, the pressure (one ton per square inch for every 800 fathoms depth) contracting the bulb and forcing the liquid up the stem. This

* Abstract of paper read before the Society of Telegraph-Engineers and Electricians on Thursday, November 8, 1888.

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was first successfully obviated in the "Miller-Cassella" thermometer, in which the ordinary bulb was surrounded by a second, the intervening space being partly filled with fluid. The author, under Captain Calver, in H.M.S. "Porcupine," had had the first use of these at sea in 1869. Some of them were exhibited through the kindness of the Hydrographic Department of the Admiralty.

Their indications were controlled also by the Siemens electrical thermometer (exhibited at the meeting), in which two coils of precisely similar construction and equal resistance at the same temperature form the two arms of a Wheatstone bridge; one of these is attached to a cable and lowered into the sea, and the bridge is balanced by altering the temperature of the water, in which the other coil is placed, on deck, when a thermometric observation of this latter gives the temperature of the submerged coil. Some deep-sea thermometers, contrived and manufactured by Messrs. Negretti and Zambra were also exhibited, in which the instrument was reversed and the mercurial column thereby detached, when the sounding line began to be hauled in.

Mr. Carpenter then made a brief reference to the "Challenger" expedition, which lasted three and a half years, traversed 70,000 miles, and established 362 observing stations, at each of which bottom temperatures were observed, and he then summarised the work of the U.S. steamer "Tuscarora," sent out to ascertain the most practicable cable route between the Pacific seaboard of the United States and Japan, in the course of which 483 soundings and bottom temperature observations were taken. The method of "serial temperature soundings" was then briefly described, by which the relation of temperature to depth was ascertained, and the way in which these results were plotted in "temperature sections" was then explained. Several of these, obtained during the cruise of the "Challenger," were exhibited. Attention was first called to a section across the North Atlantic, from Madeira, through the Azores and Bermuda, to Halifax. About two-thirds of this mass of water was seen to be below 40deg. F., the bottom temperature varying from 34·8deg to 38·7deg. In the Northern Pacific the bottom was colder, and the volume of water below 40deg. larger. In the equatorial Atlantic the bottom was equally cold, and the "bathymetrical isotherm" of 40deg. came nearer to the surface than elsewhere, so that as the surface was hotter, the fall in temperature relatively to depth was much more rapid.

The thermal conditions of partially land-locked seas was then contrasted with the above. In the Mediterranean no lower temperature than 54deg. F. was met with, although depths of 2,000 fathoms were sounded, while in the Atlantic, a short distance off, at the same depth 36deg. was met with. Similar instances were given, among them, the Red Sea, 71deg. being (as far as was known) the minimum; the Sulu Sea, in the line of the cable between Singapore and Hong Kong, where the minimum is 50·5deg. even at 2,550 fathoms, 32deg. to 33deg. being the temperature at that depth in the Indian Ocean, near the Celebes Sea, and others.

Here were well authenticated facts, and what was the explanation of them? Without going into a general discussion of oceanic physics, for which that was not the place, he would venture to say that the only satisfactory explanation to his mind lay in the idea, as to the truth of which a vast body of evidence might be brought forward, that there was a constant vertical circulation of the waters of the great oceans, due to the differences in specific gravity, caused by differences in temperatures; that the upper layers of water were moving from the equator towards the poles, and the lower layers from the poles towards the equator, their movement being affected also by the earth's rotation; that such seas as the Mediterranean, &c., were cut off from this general oceanic circulation by submarine ridges, so that their water at a greater depth than these ridges was perfectly stagnant, and no interchange with the colder water of the great oceans occurred; and, finally, that the cause of this circulation was probably to be found in the polar cold than the equatorial heat. Mr. Carpenter concluded by citing authorities in support of this view and by very briefly indicating the effect of this circulation upon climate generally.

NEW COMPANIES REGISTERED.

The Carlton Engineering Company, Limited.—Registered by Birchall, Wood and Co., 5, Mark-lane, E.C., with a capital of £10,000 in £1 shares. Object: to acquire the business of an engineer, founder and contractor for engineering works now carried on by Messrs. John Bryce Wilkinson and Frederick William Cannon (trading as the Carlton Engineering Company), at the works, Glengall-road, Millwall, S.E., and at 155, Fenchurch-street, E.C., and the goodwill thereof, and all or any part of the real and personal property of or belonging to or situate in or about or in connection with the said business, and to undertake all or any part of the liabilities of the said Messrs. John Bryce Wilkinson and Frederick William Cannon in relation thereto. The first subscribers are:

	Shares.
J. B. Wilkinson, 155, Fenchurch-street, E.C.	1
F. Smith, 5, Grange-park-road, Leyton	1
C. A. Ellis, 42, New Broad-street, E.C.	1
D. Elias, Selwyn-road, Upton Manor	1
H. A. Bennett, Woodstock Lodge, Anerley	1
H. J. Weld, The Lodge, Lymington	1
F. W. Cannon, Anerley-park, S.E.	1

With slight modifications the regulations of Table A of the Companies Act, 1862, apply.

The Humboldt Electric Power and Mining Company, Limited. Registered by Stretton, Hillard and Co., 75, Cornhill, London, E.C, with a capital of £82,500 in shares of £1 each Object: to purchase lease or acquire land, whether or not for mining purposes, mines, mining rights, water and electric power rights, minerals and mineral rights, timber and lands situate in Nevada, U.S.A., and all the rights appertaining to the same; to carry on the general business of miners by working mines or minerals, and exercising all the other rights acquired by the company. The first subscribers are:

	Shares.
J. M'Niven, 2, Colchester-street, London	1
F. Fuller, Belmont, Queen's-road, Leytonstone, E.	1
E. R. Jameson, 111, Busbey-hill, Camberwell, S.E.	1
C. S. Bensted, 156, Stanstead-road, Forest Hill, S.E.	1
H. Howard, 83, Warner-road, Camberwell	1
R. Morgan, 112, Petherton-road, N.	1
A. R. Hewitt, 15, Shepperton-road, N.	1

There shall not be less than three nor more than seven Directors, and the first shall be Sir W. G. Hunter, Geo. Reid, and L. P. Allan. The qualification of a Director shall be the holding in his own right of at least 100 shares in the capital of the Company. Each Director shall receive as remuneration for his services the sum of £100 per annum and 5 per cent. of the net profits whenever the amounts paid in dividends in any year shall amount to 12½ per cent. on the paid-up capital.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the past week amounted to £4,949.

Eastern Telegraph Company.—The receipts for October were £55,742, as against £53,089, for the same period of 1887, or an increase of £2,653.

Submarine Cable Trust.—The balance of 10s. on the coupons of the Submarine Cables Trust, due last April, will, it is announced, be paid on the 15th instant.

Direct Spanish Telegraph Company.—The traffic receipts for the month of October are estimated at £2,210, as against £2,276 in the corresponding period of last year.

Eastern Extension Telegraph Company.—The traffic receipts of this company for the month of October were £38,660, as against £40,018 for the same period of 1887.

Change of Address.—Messrs. Harvey and Peak, electricians, &c., are removing from Beak-street, Regent-street, to 6, Sandringham-buildings, Charing-cross-road, near Cranbourn-street.

Western and Brazilian Telegraph Company.—The traffic receipts of this Company for the past week, after deducting the "filth" of the gross receipts payable to the London Platino-Brazilian Company, were £4,110.

South of England Telephone Company.—The Directors of the South of England Telephone Company, Limited, have declared a dividend of 6 per cent. per annum on the preference shares for the half-year ending October 31.

Great Northern Telegraph Company.—The receipts of this Company for October, were £23,600, making a total from January 1 of £226,200, against £220,880 and £217,800 for the corresponding periods of 1887 and 1886 respectively.

Cuba Submarine Telegraph Company.—The number of messages passing over the lines of this Company during October was 4,210, estimated to produce £3,300, against 3,417 messages, producing £3,024, in the corresponding month of last year. The traffic receipts for July, estimated at £3,100, realised £3,086.

West India and Panama Telegraph Company.—The estimated receipts for the half-month ended October 31 were £2,715, as compared with £2,803 in the corresponding period of 1887. The report of this Company for the half-year ended June 30 states that the revenue was £49,965, the available balance being £23,993. The Directors have placed £2,000 of this to reserve, and propose a payment of 12s. per share on account of arrears of dividend on the first preference shares, carrying forward £1,255.

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PROVISIONAL PATENTS, 1888.

OCTOBER 26.

15,433. **Improvements in plates or electrodes for secondary batteries, and in the methods of making the same.** Thomas John Handford, 50, Bedford-row, London, W.C. (Louis Duncan, United States.)

OCTOBER 29.

15,508. **Improved methods of producing aluminium and its alloys by means of electricity.** Léon Quentin Brin and Arthur Brin, 59, Brompton-crescent, South Kensington, S.W.

15,530. **Improvements in electric indicators.** Robert William Paul, 10, Ravensdale-road, Stamford Hill, N.

15,550. **Improvements in apparatus for telephonic communication.** Joseph Sack, 433, Strand, London.

OCTOBER 30.

15,601. **Improvements in the manufacture of electric bell-push fittings.** Charles James Harcourt, 23, Southampton-buildings, Middlesex.

15,612. **Improvements in insulators for electrical conductors.** John Charles Love, 321, High Holborn, London, W.C. (Complete specification.)

15,626. **Improvements in electric batteries.** Paul Schoop, 46, Lincoln's-inn-fields, London.

15,648. **Improvements in electric switches.** William Bingham Cleveland, 18, Buckingham-street, Strand, London.

OCTOBER 31.

15,658. **Improvements in electro-magnets and their armatures.** Henry Marrain, 5, Maygrove-road, Kilburn, N.W.

15,713. **An improved connector for electrical conducting wires.** Sir David Lionel Salomons, Bart., and Harold Faraday, 53, Chancery-lane, London.

NOVEMBER 1.

15,741. **Improvements in dynamo-electric machines.** Peter V. McMahon, Ballybarrack, Dundalk, Louth.

15,755. **Improvements in the construction of dry galvanic cells and elements therefor.** Alfred James Jarman, 4, Little Moorfields, E.C.

15,766. **Ensuring the permanence of direction on the part of an electric current.** Christopher Bulman, and Arthur Benson Tiffen, 22, Southampton-buildings, Chancery-lane, W.C., Middlesex.

COMPLETE SPECIFICATIONS ACCEPTED.

NOVEMBER 30, 1887.

16,455. **Improvements in secondary or storage batteries.** Henry Thame, 55 and 56, Chancery-lane, London.

DECEMBER 1, 1887.

16,537. **Improvements in or pertaining to means or apparatus employed in the application of electricity to propel vehicles, applicable also for other purposes.** Frank Wynne, 46, Lincoln's-inn-fields, London, W.C.

DECEMBER 9, 1887.

16,962. **Improvements in stays for telegraph poles, masts, and the like.** Francis Rudall, The Terrace, 13, Lullington-road, Anerley, Surrey, S.E.

DECEMBER 21, 1887.

17,585. **Improvements in electric regulators.** Nicholas Benardos, 28, Southampton-buildings, London.

DECEMBER 28, 1887.

17,846. **Improvements in telephonic apparatus.** George Lee Anders, John Shepherd Sawrey, and Harold Collett, 20, Bucklersbury, London, E.C.

DECEMBER 30, 1887.

17,926. **Safety fuses for electrical circuits.** William Edward Hayne, 12, Ella-road, Crouch Hill, N.

JANUARY 4, 1888.

115. **Improvement in the insulation of electric appliances.** Sydney William Baynes, 13, Albert-terrace, Notting Hill Gate, London, W.

JANUARY 13, 1888.

569. **Improved method and apparatus for recording and reproducing sounds and electric currents.** Wilhelm Hedick, 69, Catharina-street, Breda, Holland.

AUGUST 16, 1888.

11,817. **Improvements in electric furnaces.** John Covert Hobbs, Cleveland, Ohio, Cuyahoga, United States.

AUGUST 17, 1888.

11,890. **Improvements in the method of stopping-off when etching or metal plating by galvanic action.** Christen Rees Bonne, 41, Eastcheap, E.C. (Ludwig Schaefer, Germany.)

SEPTEMBER 20, 1888.

13,584. **Improvements in electrical tell-tales.** Emil Meyer, 62, St. Vincent-street, Glasgow.

SEPTEMBER 28, 1888.

13,984. **Improvements in electrical accumulators.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Middlesex. (Joseph Barbier, France.)

OCTOBER 2, 1888.

14,129. **Improvements in and relating to dynamo-electric machines.** Henry Harris Lake, 45, Southampton-buildings, London. (Elihu Thomson, United States.)

SPECIFICATIONS PUBLISHED.

1887.

13,326. **Producing and administering electric shocks and currents.** J. Douglas and H. Abbott. 8d.

15,063. **Galvanic batteries.** P. Skrivanow. 4d.

16,623. **Dynamo-electric generators.** W. T. Gooldan and L. B. Atkinson. 8d.

17,089. **Electro-motors and dynamo-machines.** M. Immisch. 8d.

1888.

7463. **Commutator for magneto, &c., generators.** M. Kotyra. 6d.

12,395. **Electro-therapeutic belts.** A. J. Boult. (Pratt.) 8d.

12,706. **Storage battery plates.** W. P. Thompson. (Gibson.) 6d.

12,761. **Dynamo-electric machines.** A. G. Waterhouse. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	102
12 Feb.	1/2	Anglo-American Brush E.L.	4	4¼
12 Feb.	2/0	— fully paid	5	5¼
26 Oct.	7/6	Anglo-American	100	47½
26 Oct.	15/0	— Pref.	100	79¾
12 Feb., 85	5/0	— Def.	100	17¼
28 June	3/0	Brazilian Submarine	10	13½
14 June	1/0	Con Telephone & Main	1	1⅛
10 Aug.	9/0	Cuba	10	14
10 Aug.	10/0	— 10% Pref.	10	18½
12 Oct.	2/0	Direct Spanish	5	4
12 Oct.	5/0	— 10% Pref.	5	10¼
26 Oct.	2/0	Direct United States	20	10¼
12 Oct.	2/6	Eastern	10	12⅜
12 Oct.	3/0	— 6% Pref.	10	14⅞
1 Aug.	5%	— 5%, 1899	100	110
26 April	4%	— 4% Deb. Stock	100	110
12 Oct.	2/6	Eastern Extension, Australasia & China	10	13⅛
1 Aug.	6%	— 6% Deb., 1891	100	104½
2 July	5%	— 5% Deb., 1900	100	104
2 May	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	105
28 Mar.	8/3	German Union	10	9⅛
12 Oct.	3/0	Globe Telegraph Trust	10	7⅛
12 Oct.	3/0	— 6% Pref.	10	14¼
30 April	5/0	Great Northern	10	14¼
1 March	5%	Gt. Northern 5% Deb., '88.	100	108½
27 July	10/0	India Rubber, G. P. & Tel.	10	17
11 May	37/6	Indo-European	25	39½
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	7/16
26 April	4/0	Reuter's	8	8
		Swan United	3½	2¼
10 Aug.	13½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13½
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	98
12 July	4/0	West Coast of America	10	8
30 June	8%	— 8% Debs.	100	115
11 May	9/0	Western and Brazilian	15	13⅜
11 May	6/10½	— Preferred	7½	7⅛
11 May	2/1½	— Deferred	7½	7
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	2⅛
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80		— 6% 2nd Pref.	10	12
2 May	7%	West Union of U.S.	$1,000	125
1 Mar.	6%	— 6% Sterling	100	102

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NOTES.

Norwich.—With reference to the Norwich installation, we understand that the arrangement for cables are not completed.

Morecambe.—Messrs. Andrews and Preece, of Bradford, have written to the Board to give notice of their intention to apply for a provisional order.

Observatory Lamps. — The instruments at the Greenwich Observatory are being fitted up with small electric lamps supplied by Schanschieff batteries.

Cox-Walker Swinton Magneto Bells.—These have been awarded a medal at the recent exhibition of the Royal Cornwall Polytechnic Society, at Falmouth.

Wath.—Messrs. Stanley and Son's soap works at Wath, near Barnsley, are lighted throughout with electric light. This is the first introduction of the electric light in Wath.

Society of Telegraph-Engineers.—At the meeting on Thursday, November 22, at 8 p.m., a paper will be read "On a System of Electrical Distribution," by Henry Edmunds, member.

Gas for Motors.—The foreign gas companies in many cases give special terms for consumers of gas for gas-engines. English companies might imitate the idea with considerable benefit.

Magnetism.—La Société Magnetique of France have organised an international congress to be held at the time of the Paris Exhibition. Partisans of magnetic theories of all schools are invited to attend.

Sunderland.—The Sunderland Co-operative Stores have just been lighted with three Gulcher arc lamps, together with incandescent lamps. A 3,000-c.p. lamp is placed on a bracket in front of the building for lighting the street.

India.—Why is it that we hardly ever hear of electric light plants for India? There must be a vast field in that country. The contrast between the activity of the land of the Red Indians and that of the Hindoos is very poor indeed for the latter.

Railway Lighting.—A man has been killed in the goods yard, near the electric light station, at Hastings, while shunting. The jury expressed the opinion that advantage should be taken of the possibility of obtaining more light in the yard.

Lyndhurst.—The proposal to construct an electric road at Lyndhurst has led to the proposal that the ordinary railroad, which, owing to opposition at its initial stage, was terminated some three miles away, should be extended by a loop-line to the village.

Fire Detector.—The highest award in its class at the Cardiff Industrial Exhibition has been given to Douse's patent automatic fire check. Some very successful demonstrations have been recently given, and we hope shortly to illustrate it in our columns.

Book on Electrical Lighting.—A new and revised edition of "Elementary Principles of Electric Lighting," by A. A. Campbell Swinton, is now in the press, and will shortly be published by Messrs. Crosby, Lockwood and Co. The first edition is out of print.

Canada Cables.—The Canadian Government has decided to invite the Australasian Governments to send delegates to Canada at an early date, to consider the trade relations between the colonies, and especially the question of cable communication *vid* the Pacific.

Meteorology.—A paper on "The Investigation of the Phenomena of English Thunderstorms, 1857-59," by G. J. Symons, F.R.S., will be read at the meeting of the Royal Meteorological Society, at 25, Great George-street, on Wednesday, 21st inst., at 7 p.m.

The Overhead Difficulty.—Questions are about to be put to the President of the Board of Trade with regard to the operations of certain companies which propose to distribute the electric light over the metropolis. It is believed that the plans which these companies have in view will involve an enormous addition to the overhead wires.

Pasting Machine.—Elwell-Parkers have, we hear, introduced a machine for making the grids for storage batteries, by which the lead plates can be rolled out, and the edges of the spaces burred over, so as to effectually prevent the paste dropping out. This process also is said to make the plates stronger, and very considerably reduces the expense in manufacture.

Combination Telephone.—A new arrangement of telephone has been introduced by Messrs. Mix and Genest, of Berlin, in which the mouthpiece and receiver are fixed on the same arm, and are placed in position in front of the mouth and against the ear with one motion of the hand. This convenient form of telephone has been adopted by the German military administration.

Rolling Mill.—The Gulcher Company have secured the contract for lighting Messrs. W. and J. Players' new rolling mill, Spring Hill, Birmingham, with electric light. Six 2,000-c.p. Gulcher arc lamps will be used for lighting the mill, and the dynamo and engine are being put in large enough for 10 lamps, in case it is necessary to extend the mill, in which case the remaining power will be used for running incandescent lamps.

The Montreux Disaster.—The accident at Montreux last week was due, it seems, to the difficulty of understanding the telephone. The reservoir which furnished the motive power of the Chillon electric tramway being so full as to cause apprehensions, the man in charge was telephoned to in the words, "*Ne mettez plus d'eau.*" He did not catch the first two words, and consequently turned on more water, the result being that the reservoir burst, with loss of life and great damage to property.

The Ball Season.—The winter brings round its festive scenes with balls and dances, and the electric light will be called into requisition for beautifying and enhancing the triumphs of decorative art. It may be well to remember the means by which success was achieved at Delmonico's ball, where millionaire heiresses were to be delighted. Everyone of the 400 lights was enveloped in a little bag of straw-coloured silk, and the effect was to bathe the scene in a flush of tempered sunlight, and transform everything but the most uncompromising ugliness into a semblance of beauty.

Accidents.—Two preventible accidents are reported from France. In one the storage cells were used at the beginning of the performance. When the dynamo failed, the cells were so exhausted that no light could be obtained, instead of there being a supply to fall back upon. In the other case, a danseuse touched the wires, which were bare, with a part of her dress stiffened by wires. A flash occurred, and in a moment her muslin skirts were

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in flames. The beauties of electric light come before the public more, perhaps, in theatre lighting than any other way, and accidents of either of these kinds ought not to be possible.

Car Loads of Electricity.—The sight is now becoming common, so often anticipated by popular writers on electricity, of cars of storage cells to be seen depositing their loads of electric power at the customer's door. An instance of this was seen in Fleet-street on Wednesday, when a car load of cells from the Electrical Power Storage Company were being taken into a court for lighting the bazaar to be held in the Leopold Rooms, St. Bride-street. The ball season will doubtless make the sight much more common, the advantages of the temporary supply of electric light for this purpose being very much appreciated last winter.

Manganese.—The well-known manganese merchants, Messrs. S. G. Bailey and Co., lately of Plymouth, have removed to much larger premises at Stafford Mills, Stroud, Gloucestershire, owing to increasing business. Besides their old trade of crushed carbon and manganese they are now manufacturing pure borate and sulphate of manganese, and are offering the richest ore, testing 87 to 95 per cent., at a very cheap rate. Their ability to supply these goods cheaply is due to the presence of enormous water power at their new mills, and the most improved machines have been erected for pulverising and granulating the manganese and carbon.

The Great Industry Coming.—We have hardly touched, says President S. S. Duncan in the American *Street Railway Journal*, the great industry of the distribution of power. At the present time there are constructed and being constructed 83 electric railroads, aggregating 327 miles of single track, and working 467 motor cars. It is estimated that the electric cars now in operation in the United States will have carried at the end of the year 1888 no less than 17,045,500 passengers, and it can be better imagined than estimated what will be the ultimate outcome of an industry which has arrived to such a degree of development in three years.

Richmond.—Richmond has been enquiring further with regard to electric lighting. The West Middlesex Electric Lighting Company have applied, and information was asked by the clerk from the Barnet Local Board; in the course of the correspondence it came out that Richmond pays £3. 6s. 8d. per lamp for gas, as against Barnet £2. 18s. Messrs. Laing, Wharton and Down have also written, offering to carry out the installation for the Richmond Board, and a local man has made a bid—to give a sum down, and 1s. per lamp royalty—to be allowed to supply the inhabitants. The clerk has reported the receipt of the draft license from the Board of Trade.

Birmingham Lighting.—It is thought that the General Purposes Committee will recommend that the consent of the Council to the application of Messrs. Chamberlain and Hookham be withheld, and that it be postponed for future consideration, the reason being that the suggested alterations of the terms were received too late for due consideration. It is also expected that the committee will assign the reason that it may be desirable for the Council itself to obtain a provisional order, and grant licenses to those who may be desirous of supplying the light. This would postpone the matter for another twelve months, but it is open to the undertakers to apply to the Board of Trade for an order without the consent of the Council.

Architects and the Electric Light.—At the annual conversazione of the Society of Architects, which was held on Tuesday at the New Gallery, where the Arts and Crafts Exhibition is being held, the president, Mr. W. H. Seth-Smith, in the course of his address referred to the important place that electric light was taking in the present methods of illumination. The great facility with which the incandescent light could be manipulated to produce decorative effect was worthy of greater and continued attention by architects, who should consider the special designs by which it could be used with beautiful effect. He also pointed out to the attention of architects that greater provision for ventilation was often necessary in cases where the electric light was used, as the comparative absence of heat did not afford so much natural ventilation.

Chamber of Commerce.—The committee of the Electrical Section have elected Mr. R. E. Crompton for its chairman, and for vice-chairmen the Earl of Crawford and Major Flood Page. The committee are desirous of proceeding to the discussion of questions primarily affecting the trade, and invite the opinion of members as to the most pressing topics for immediate consideration.—A special meeting of the Electricity Supply Companies Sub-Section will be held at the offices of the chamber, Botolph House, Eastcheap, to-day, the 16th inst., at 3 p.m. The following is the order of discussion: (1) To consider the regulations for provisional orders for electric lighting under the Board of Trade rules, and to discuss certain modifications proposed to be introduced by the Earl of Crawford, Mr. Hammond, and others. (2) To discuss the relations between electric lighting supply companies and the local authorities with which they come in contact.

Ironmongers' Exhibition.—The first exhibition under the title of International Ironmongers' Iron and Metal Trades Exhibition was opened at the Agricultural Hall on Monday last, and will continue open till the 24th inst. The exhibition has been organised by Mr. Harry Etherington. From the electrical engineer's point of view this exhibition contains little that is interesting, only two exhibits of an electrical character being found therein. They are those of the General Electric Company (Messrs. G. Binswanger and Co.), of St. Thomas Apostle, who exhibit a fine display of Clark's electric gas lighters, as well as all that pertains to electric bell work in the shape of bells, pushes, batteries, a number of electric light fittings, glassware, and also telephonic apparatus. The exhibit of Messrs. Appleton, Burbey, and Williamson, of 91, Queen Victoria-street, consists principally of electric light fittings, adjustable switches of various kinds, and Lea's patent globes. This firm is lighting, besides their own exhibits, three other exhibits with incandescent lights driven from a Gramme machine from one of Hindley's engines.

Department of Science and Art.—Mr. W. Crookes, F.R.S., has presented to the Department of Science and Art a collection of sixty-eight radiometers, and similar instruments, for permanent exhibition in the science galleries of the South Kensington Museum. They illustrate the steps by which Mr. Crookes was led to the construction of the radiometer, and to the production of motion and of phosphorescence by streams of electrified molecules in high vacua. Many of the instruments are of the greatest historical interest. Among them is included the first radiometer, with many others which are described in Mr. Crooke's

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papers in the "Philosophical Transactions of the Royal Society." Others are of considerable value, as they contain collections of diamonds, rubies, etc., for the exhibition of the phenomena of phosphorescence. Nearly all are in working order, and will be of great use in illustrating lectures to students in the Normal School of Science at South Kensington. The collection will be on view in the galleries of the museum in Queen's-gate as soon as the necessary stands and fittings are completed.

The London Electric Corporation.—Some particulars, says *Money*, of the corporation and its position will be found interesting. Of the nominal capital of £1,000,000, in £5 shares, rather more than half is at present subscribed, the precise figures being £535,000. The company is by no means a public company in the full sense of the word, for more than four-fifths of the capital subscribed has been found by an inner ring of twenty-eight financiers. These are headed by Lord Wantage, who alone holds not far short of a quarter of a million's worth of these shares. After him come seven holders who have subscribed for 21,752 shares; then fifteen who have taken 23,833 shares; and, finally, five others who hold amongst them 2,766 shares. Besides Lord Wantage's £220,000, therefore, no less than £241,755 have been found by twenty-seven other holders. There are in all fifty shareholders, about twenty of whom have subscribed the balance of about £78,000 amongst them. And it is this small but rich syndicate which proposes, taking the requirements of London to be equivalent to 7,000,000 10-c.p. lamps, to light more than a quarter of the metropolis.

Details from Dusseldorf.—The Art School in Düsseldorf is lighted by the electric light, and the following particulars are given of the first complete year's run. Gas-motor, 16 h.p.; driving hours, 635¾ hours on 199 days; glow-lamps, 112; lamp hours, 52,095. Expenses: Gas (motor), 284,450 cubic feet, at 2s. 10d., £40. 5s. 7d.; gas lighting, 3,022 cubic feet, at 4s. 6·4d., 13s. 9d.; gas-meter hire, £1. 16s.; water, 18,940 cubic feet, at 3s. 4¾d., £3. 4s. 9d.; water meter hire, 10s.; engine oil, 521lb. at 2¾d., £7. 2s. 2d.; petroleum, 79·2lb. at 1·23d., 9s. 9d.; cotton, 13·2lb., at 1·13d., 1s. 6d.; wages of machinist, 895 hours, at 6d., £22. 7s. 6d.: repairs and maintenance, £5. 2s.; depreciation, &c., 10 per cent. on £840, £84; total, £165 13s. This corresponds to 0·762d. per 16 c.p. lamp per hour, or to gas (sixteen candlelight, with 5ft. burner) at 12s. 8·4d. per thousand cubic feet. The gas used was 28 cubic feet per h.p. per hour; per glow-lamp per hour it was 5·46 cubic feet. Five lamps were renewed, duration exceeding 800 hours. Three short stoppages, caused by the kindling aperture of the gas-engine becoming blocked up. The slide was cleaned twelve times, valves inserted ten times, and the cylinder cleaned once. In the dynamo the brushes were renewed twelve times, and the machine itself twice shifted, in order to tighten the belt.

Telephony at Bournemouth—We are glad to see that the local papers are praising the action of the Western Counties and South Wales Telephone Company. It seems to us that outside of London telephone management is viewed in a different light to what it is in the metropolis. There is a go-aheadness in the one case that is lacking in the other. The Western Counties Telephone Company is very active in installing systems in various towns within the district, and among these it is satisfactory to notice that good work is being done at Bournemouth. It is stated that all preliminary details for the extension of telephones from Portsmouth to Gosport, Fareham, Winchester, Southampton, and Bournemouth have now been settled, and permission is now held by the company to erect wires along all the main roads of these towns, so that we may expect very shortly this work will be taken in hand. The proposal originally put forward was to bring the towns in the South of England all into communication, or at any rate, the more important of them, such as those which we have mentioned, with Salisbury, Bath, Bristol, and the large towns in South Wales. The number of subscribers at Bournemouth is nearly two hundred, of which number fifty have been added during the past year, and the number of calls, on an average, reach between four and five hundred per day.

The Westinghouse Company.—Further details of the omnivorous character of this company reach us, and we should imagine that if the enterprise of any American company is to be guarded against in this country it is this company, which will be found to be the keenest rival in competing for business. We believe that the large contract for the Sardinia-street works has been given to the Westinghouse Company, whose tender has beaten the home firms upon their own ground. Its latest absorption is the Consolidated Electric Light Company, of New York, whose property consists of a big manufactory of the Sawyer-Man incandescent lamps in New York and in Pittsburg, with all their plant and stock. The use is given to the Westinghouse Company of all the patents in its possession and the entire capital stock of the Sawyer-Man Electric Company. In return the Westinghouse Company pays to the 150 stockholders of the Consolidated Electric Company 150,000dols. per year, quarterly, equal to a yearly dividend of 4 per cent., until certain indebtedness of the Consolidated Company is liquidated, when the dividend will be increased to 6 per cent., and a royalty of 1 cent. for every Sawyer-Man lamp sold, which is expected to double the annual dividend of 6 per cent. The Westinghouse Company also contracts to subscribe for the unissued stock of the Consolidated Company, now amounting to a par value of 125,000dols. Thus the agreement practically constitutes the Westinghouse Company trustee of the business of the Consolidated Company, the latter becoming merely an investment corporation, whose sole duty will be to transfer stock and pay dividends.

Ferranti.—Besides the work at Deptford, Mr. Ferranti has been supplying dynamos for various central stations on the type of the Grosvenor Gallery installation, but smaller. One of these has been started at Chatham, and comprises one 150 h.p. Ferranti machine, driven by Hick-Hargreaves' engine, indicating 60 h.p., with Babcock and Wilcox boilers, Worthington pumps, and transformers, cut-outs, switches, etc. This installation was started, we are told, without a hitch, with 400 lamps lighted the first night. Another central station, starting at first with the same size plant, has been supplied to Glasgow. Another plant of 300 h.p. dynamos has been supplied to Nancy, France, where the Ferranti dynamos and transformers are supplanting a Zipernowski plant. Not only is the Ferranti system conflicting with the Zipernowski system abroad, but will prove itself, if what we hear is true, a formidable rival to the Westinghouse system in the States. Hitherto, Westinghouse has had it all his own way, and even has threatened an influx into England,

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but the installation of a large Ferranti plant for central lighting in one of the best known United States cities will cause one of the biggest commotions heard over there for a long time. English men and English money are entirely employed in this system, agents are being appointed in various quarters, and we shall find, we think, under the skilful hands that have charge of it, another instance of the prestige of English engineering being far to the fore.

Electric Lighting.—The work done by the Edison Company in Berlin is so good that the public and the municipal authorities have perfect confidence in their ability to extend their central station work still further, and a concession has been given to this company for the establishment of two new stations—one in the centre of the town and the other in the south-east quarter, where most of the engineering works and other factories are situated. Both stations must be ready within two years, and each must be able to supply current for 6,000 glow-lamps burning simultaneously. The station in the centre of the town will eventually be increased to a capacity of 24,000 lamps, and the other station will be increased to 12,000 lamps, the annual increase to be not less than 6,000 and 3,000 lamps respectively. All the cables required in connection with these stations must be in position by the end of 1892, and the supply of current within both districts will be compulsory, provided the customer is willing to take the light for at least one year. The network of cables to be laid down in connection with these stations is very complete, and practically comprises all the streets or the respective districts, some small and unimportant side streets alone excepted. In view of this extension of the business, the Edison Company propose to increase their share capital at present by £150,000, and later on by £300,000. The electric light installation in the Monopol Hotel of this town, which comprises 1,000 lamps, will shortly be in action. The work has been executed by the Berliner Maschinenbau-Actiengesellschaft, under the superintendence of Herr Beringer. The current is supplied by two 80 h.p. dynamos, each direct coupled to a twin engine. The dynamos are of the 8-pole disc type, and are compound wound. Steam is supplied by two Babcock and Wilcox boilers, having collectively a heating surface of 24,000 square feet.—*Industries.*

Discoveries and Inventions.—We have received a circular from the Franklin Institute requesting publicity for awards and certain medals given for meritorious discoveries and inventions which tend to the progress of the arts and manufactures. These medals are the Elliott Cresson Medal (gold), given for some discovery in the arts and sciences, or for the invention or improvement of some useful machine, or for some new process or combination of materials in manufactures, or for ingenuity, skill, or perfection in workmanship; the John Scott Legacy Premium and Medal (20dols. and a medal of copper), to reward ingenious men and women who make useful inventions. The premium is not to exceed 20dols., and the medal is to be of copper, and inscribed "To the most deserving." The control of the Scott Legacy Premium and Medal (by Act of 1869) was transferred to the Board of Directors of City Trusts, and referred by the board to its committee on minor trusts, and that committee resolved that it would receive favourably the name of any person whom the Franklin Institute may from time to time report to the Committee on Minor Trusts as worthy to receive the Scott Legacy Premium and Medal. The Franklin Institute, by resolution in 1882, accepted the above-named action of the Committee on Minor Trusts, and referred the duty of making such recommendations to the committee on science and the arts. The committee determined that the recommendation for such reward shall be made on the favourable report of a sub-committee which shall be appointed to examine the invention or discovery. The committee requests co-operation in facilitating the making of the aforesaid awards for meritorious discoveries and inventions, by bringing the facts herein set forth to the knowledge of our readers. Upon request, therefore, from interested parties, made to the secretary of the Franklin Institute, full information will be sent respecting the manner of making application for the investigation of inventions and discoveries. Furthermore, the Committee on Science and the Arts will receive and give respectful consideration to reports upon discoveries and inventions which may be sent to it, with the view of receiving one or the other of the awards herein named, and full directions as to the manner and form in which such communications should properly be made will be sent on application.

Installations.—One of the largest installations for a country mansion that has yet been done is for the Earl of Rosebery, K.G., at Mentmore, where there are 700 lights, with complete duplicate machinery. This is now being finished by Messrs. B. Verity and Sons, of King-street, Covent Garden, W.C., and is the second order they have had from that nobleman. Another similar installation is being put down for Sir John Dixon Poynder, where there will be nearly 500 lights, and duplicate machinery. Messrs. Verity and Sons are also just starting on the "Savoy Mansions" for Mr. D'Oyly Carte, the installation being for 3,000 lights; Willans engines and Siemens dynamos are being used. Another installation just finished is the steam yacht "Eros," for M. le Baron Arthur de Rothschild, of Paris, who has evidently preferred giving the order to an English firm rather than to a French one. Willans engines are employed, and the interior of the yacht, which is a small palace, has some of the most costly gilt and silver fittings ever made. Besides these works, the same firm have at the present time upwards of 35 smaller installations or wiring works in progress, including the Earl of Dysart, per General Webber; Sir David Salomons, Bart.; the Royal College of Surgeons; an additional plant of 340 lights for Holloway College; Avenue Theatre, 600 lights; re-wiring of the Isthmian Club, Piccadilly, and Sir William McCormack's house; wiring for 1,200 lights for Lord Walsingham's Chambers, in Piccadilly; Mr. Peter Robinson's private house, Mr. D'Oyly Carte's private house, Mr. Mather's (of Messrs. Mather and Platt), and Dr. Lennox Browne's, etc., etc. Another work just completed, worthy of note, is the complete re-wiring of the Junior United Service Club, about 340 lights. The whole of this work, including the manufacture of new electroliers and fittings throughout the place, was completed in exactly three weeks, and a special letter of satisfaction was sent by the committee. Messrs. Verity and Sons have been giving great attention to the designing of new and beautiful fittings, those lately alluded to by us in their catalogue being a mere tithe of what they are producing. The number of private installations carried out has given them great scope and opportunity for the designing of new and specially high-class electric fittings, and these are greatly appreciated by the electrical trade in general. In one installation for Mr. Fellowes, at Palace Court, Kensington, some valuable replicas of Louis Seize "*bras de lumiere*"

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have been utilised for making into electroliers with very happy effect. Among electric fittings, the principal electroliers are being made for the Glasgow municipal buildings, and some very high-class fittings have recently been completed for her Majesty's yachts, "Victoria and Albert" and the "Osborne." The state of business is very well indicated in this recital of the work of one firm; every installation mentioned is either now in hand, or has been finished during the last three weeks.

Barnet.—Bandying compliments, or anything that savours of personality, does not commend itself to us; but our friendly critic in the *Electrical Review* is hardly to be congratulated in his attempts to make capital out of our remarks on the Barnet lighting. Doubtless we both agree upon most of the points arising out of this question, and our contemporary will have found out by this time that there is something of the nature of a mare's nest about the "week's grace" and the termination of the contract. Opinions may differ as to the taking of a contract for lighting in this particular fashion, but we opine that is not the real point just now at issue. The question is rather, has the contractor provided what he contracted to give? He says he has. Our own representative was more favoured that the representative of our contemporary, and his statement is that the light given is better than the gas; that, with one exception, the people questioned—perfect strangers to him, be it remembered, and unacquainted with his profession—admitted that in their opinion the light was better than that of gas. We are not acting in the interests of Mr. Joel; in fact, we know far less of Mr. Joel than of almost any other worker in electrical matters. All we ask for is, that every man should have fair play. He has not had fair play. The whole of the gas interest has been moved against the Barnet lighting. It is self-evident that the trade papers devoted to electricity did not all speak from their own experience, though the information they extracted from opposing articles was rather calculated to make it appear so. One word as to reports and amendments at local boards. While giving them the closest attention, we must not be too hasty in coming to conclusions. An active minority can always obtain reports and propose amendments, and generally to outsiders make it appear that the whole thing is on its last legs. This may be true, but just as often the opposition is converted and becomes the most strenuous supporters of what they once tried their very best to damnify. "Climbing down" is the political phrase indicative of such a policy, and it is not an unknown operation in local bodies. Technical criticism comes to this: (1) The system adopted is not the best system for the purpose. Answer: The buyer would have none other. (2) The contract was taken at too low a price. Answer: The contractor demurs, and contends that taking this work at the price was business-like and justifiable, giving him—or the company—a firm and substantial basis upon which to extend operations and obtain good profits. (3) There should have been no preliminary shuffling with temporary plant—that the permanent plant should have been installed at the first. Answer: The contractor fully admits this, but says the decision to light was postponed time and again, till finally, having to light by a certain day when gas would no longer be available, there was no help but to put in temporary apparatus, and the purchasers, not the contractor, should be blamed for such a state of things.

Barnet Local Board.—The resolution that the contractor should be requested to remove the electric light was not carried. Mr. James thought that the notice would have the effect upon the contractor of "spurring him on." In moving the amendment, Mr. Samuels said that if he had had time at first to examine the form of contract as carefully as he had since been able to do, he would never have been a party to the recommendation that the notice be given. The clause had reference alone to defects in electric lighting, and it was not in the province of the Board to institute enquiries as to engines or appliances. The contractor had pointed out the first lamp on the right-hand side of the New-road as the sample of what he intended to supply, and the committee having viewed it, deemed it very satisfactory, or rather (for he did not at any time care for the use of extreme terms) they agreed that it was satisfactory. As to the time at which all lamps would be equal to sample, Mr. Joel had given them written evidence to prove that the lamps had not been delivered by the makers according to order, and he had done all that could reasonably be expected—namely, undertaken to fix them with the least possible delay when they were received. As to the engine, so long as they got a satisfactory light, it was no affair of theirs how Mr. Joel generated his electricity. Mr. Joel frankly admitted that some of the lamps were unsatisfactory, and engaged that at the earliest possible moment they should be equal to the sample lamp; he had gone beyond that, and had given information which they as business men need not have expected him to give. How did they find themselves? Within the last 14 days he submitted confidently that the light had been very much better than at starting. The best test was to see what was the effect when the shop lights were out, and having inspected the lamps under those circumstances he had no hesitation in saying there had been a marked improvement in a fortnight. A means of testing the light was to stand at one lamp and looking towards the next, see how the intervening space was illuminated, and he ventured to say that anyone standing near the lamp at The Salisbury, and looking towards the one immediately opposite, must admit that no ordinary gas lamp would have anything like that effect at the same distance. The light in the New-road, to which he had already referred, was sufficiently strong to illuminate a room at the back of his house so that the time could be seen by a clock in the room, and to throw the shadow of the window-bars on the opposite wall. He admitted there were not enough lamps, but that was the matter of the Board; they had put up 71 lamps instead of the 120 original gas lamps. Of course the cost came in, but that was a matter governed by the contract, and while it might go to the question of the economy or otherwise of electric lighting, it did not go to the question under which it was proposed to give notice. Within a fortnight they had got a result that must, he thought, be deemed satisfactory, and by continuing to pursue a helping policy, they would get a result which would not be attained by giving notice. What the contractor undertook on Friday night to do he appeared to be carefully doing, and, in fact, to be doing his very best under the circumstances, and they would not be acting in a proper spirit if they acted towards Mr. Joel in a manner other than that in which they led him to suppose they intended to act. He would move as an amendment that the recommendation of October 5 be not acted upon, and that the undertakings of Mr. Joel be accepted. This was carried.

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NOTES ON CHOOSING AND INSTALLING ELECTRIC LIGHT PLANT.

BY L. A. DAVIES, A.S.T.E. AND E.

(Continued from page 383.)

It is of great importance that the driving power should be transmitted to the armature-shaft without jerks and irregularities, as these are not only disagreeably perceptible in the lights, but tend to cause sparking and troublesome flats on the commutator, necessitating periodical re-turning. When the power is transmitted to the dynamo-shaft by means of belting, the distance between the centres should be made of ample length, and care taken that the belt runs smoothly over the joints and with the lap. A long, slack belt lasts longer and gives less trouble than a short tight one, while not necessarily causing greater slip.

The width necessary to transmit a given power for good leather single belts of $\frac{3}{16}$in. thickness may be calculated from the formula

$$W = \frac{1100 \times H P}{V},$$

where

W = width of belt in inches;
H.P. = actual h.p. to be transmitted;
V = velocity of belt in feet per minute.

For double belts multiply W found by above formula by 0·6.

The strain per square inch on a belt is halved by doubling its width, and especially in very short open belts it is wiser to increase the width than to make the belt very tight, as the latter plan causes constant trouble through hot bearings, and giving out of lacings, etc.

When driving from a large pulley on to a comparatively small one, with short centres, the belt will get an insufficient amount of grip on the driven pulley, but this may be remedied by placing a loose pulley close to the latter, and in such a position as to force the belt to travel round a greatly increased proportion of its periphery.

It is a good plan when a dynamo is to be driven by belting to fix it on a sliding bed, in such a way that the belt can be tightened up when too slack without having to stop in the middle of a run to undo and relace.

The employment of high-speed engines like the Willans and Westinghouse, having their crankshafts coupled direct to the dynamo-spindles, does away with all these troubles, and at the same time greatly economises space, and these motors are consequently coming into extended use. They are more expensive than slow-speed engines in first cost owing to the great care that has to be paid in their construction, to the accurate balancing of their moving parts, and to their lubrication, but experience has shown them to be perfectly reliable in working. When an engine of this class is adopted, the dynamo and engine are fixed on the same bedplate to avoid undue strain on the coupling-shafts, bearings, etc. The engine and dynamo being thus in one frame, so to say, comparatively light foundations are needed, there being no lateral strain to resist, and a saving can be thus effected here.

Some engineers have, however, an objection to the employment of engines running at such high speeds as 400 or 600 revolutions, and, when space has to be economised, prefer to fix the machine on the engine bedplate, and drive it with a belt in the ordinary way, but assisted by a friction pulley placed between the engine and dynamo pulleys, and bearing on its periphery against both the others. There is, no doubt, however, that the direct coupling system is preferable to this plan, being less complicated.

Turbines are well suited to driving electric light machinery, owing to their steady running and easy control.

The instances in which turbines can be adopted for electric lighting are comparatively few, but a short notice of these motors may be added.

There are so many varieties of turbine now in the market that the best form for a particular case must be decided in each instance according to the circumstances of head and volume of water supply, etc

Knowing the available head and volume of flow of water available, the theoretical h.p. may be calculated from the formula

$$P = \cdot 001892\, Q\, h,$$

where

P = theoretical h.p.;
Q = volume of flow in cubic feet per minute;
h = head in feet measured above tail race;

and

$$Q = \frac{528 \cdot 5\ P}{h};\ \text{and}\ h = \frac{528 \cdot 5\ P}{Q}.$$

Turbines can be reckoned on to give fully 75 per cent. of this theoretical power, and the following table gives the value of Q for 1 h.p. under heads from 1ft. to 390ft., calculated at this efficiency.

Head	1	10	20	30	40	50	60	70	80	90
	704·	70·4	35·2	23·5	17·6	14·1	11·7	10·0	8·5	7·8
100	7·0	6·4	5·9	5·4	5·0	4·7	4·4	4·1	3·9	3·6
200	3·5	3·3	3·1	3·0	2·9	2·8	2·7	2·6	2·5	2·4
300	2·3	2·2	2·2	2·1	2·1	2·0	1·9	1·9	1·8	1·8

The question of the style of lighting to be adopted has been already gone into, and the reasons given which should decide whether arc or incandescent lamps are best suited to any particular case, and these need not be again considered Incandescent lamps of high candle-power are now becoming largely used; though not so efficient as arc lamps, they are more efficient than low candle-power incandescent lamps, the proportion of watts per candle-power being about ·3 in the case of arcs, 2·0 in high candle-power incandescents, and 3·7 in small incandescents. The life of high candle-power incandescents at the above proportion of two watts per candle-power is not of great duration. They can, however, be run at a lower rate of efficiency, or about 2·5 watts per candle-power, and as long a life obtained as has been reached by low candle-power lamps. For many purposes these lamps are very suitable, as they have not the intensity of the arc light, the light being emitted from a comparatively large surface at a lower temperature, while they require no daily attendance for recarboning, etc. They are usually made to run (in parallel) on circuits of from 50 to 100 volts, so that they can be worked in combination with ordinary small incandescents of similar voltages.

The leads for electric light circuits should be calculated at the rate of one square inch of sectional area per 1,000 amperes. The Board of Trade limit is 2,000 amperes per square inch, but it is necessary to keep well within this to allow of accidental increase of current without overheating. At this current density the fall of potential along the circuits will be at the rate of 2·5 volts per 100 yards of lead, and allowance must be made at this rate when estimating the necessary difference of potentials between the terminals of the dynamo according to the voltage of the lamps to be used. For instance, a 100 volt incandescent lamp of 16 c.p. (taking a current of ·6 amperes) at a distance of 100 yards, would require a No. 22 B.W.G. lead, and an E.M.F. of 105 volts at the machine. This rule is, of course, equally applicable to both arc and incandescent circuits, excepting that when bare wires are used, as for outdoor leads, a higher current density may be safely employed.

Wiring for indoor work is usually specified to be carried out in accordance with some well-known rules with regard to the precautions to be observed against fire. Very few cases of fire have been really traced to electricity, as compared with gas, oil, and other means of illumination; but in order that this good character may be maintained for electric lighting it is essential that good workmanship, good material, and care should be used in the work of installation. Gas or water-pipes, or other "earth," should never be used as a "return lead." The insulation of the leads should be of the best quality—indiarubber or guttapercha in dry places, and guttapercha in wet, if it is necesary to run in wet places, but they are best avoided altogether—and protected from accidental abrasion by outer servings of tape, or, better still, braid. It is advisable, where possible, to run the conductors in leads on the surface of the walls, ceilings, etc., and enclose them in continuous wood

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casing, in which the positive and negative leads can be kept at a regular distance apart by a wood fillet running continuously between them. The covering over this casing should never be nailed on but fastened with screws, so as to allow of its being readily removed for inspection. Wires passing through walls should be enclosed in separate tubes, preferably of metal or earthenware. Brass saddles are better than staples for securing the wires to walls, etc., but the former can be used if the precaution is taken of inserting a piece of felt or indiarubber under the head of the staple. Acid should never be used for soldering joints, as it is difficult to remove the last traces of acid, and these are quite sufficient to set up corrosion with a likelihood of heating, and possibly solution of continuity and arcing. A great safeguard against overheating of leads is the judicious use of cut-outs. Ceiling-plates, wall-sockets, and switches (main and branch) are now usually fitted with these appliances, which consist simply of a short length of lead, tin, or other fusible metal, clamped firmly in suitable terminals, and inserted in the circuit to be protected. These lengths of fusible wire must be of such a diameter that they will only carry a definite increase of current over the normal 1,000 amperes per square inch (generally 50 per cent.) without melting and breaking the circuit. Cut-outs, however, have been known to fail through a film of infusible oxide forming on the surface of the fusible wire, and so maintaining continuity. To get over this difficulty, the Cockburn cut out was brought out. In this cut-out a weight is hung in the centre of the fusible wire to ensure a complete breakage occurring at the correct temperature. All small enclosed switches should be provided with spring breaks to avoid all risk of the connecting tongue remaining half off and half on, and so forming an arc. The backs of all ceiling-plates, switches, cut-out boxes, etc., should be of some infusible material, such as earthenware or slate. If these precautions are followed there will no danger of accident or fire occurring, provided that, as said before, good workmanship is employed in fixing.

The precautions to be taken in running outdoor circuits for arc lamps are comparatively few and simple. The wires should be insulated well if intended for use with high-tension currents (especially if alternating, as these latter are more dangerous to life), and the conductors should be kept well apart. In low-tension parallel circuits there is not the same need for high insulation, but it should be borne in mind that a short circuit on any part of the circuit means in this case an extinction of all the lamps. There is, however, no danger to life from these currents.

(To be continued.)

N.B.—In the comparison given in the preceding portion of this article of the consumption of water in engines when working expansively and non-expansively, the number of pounds of water consumed was stated by a printer's error as being "per horse-power per hour" instead of simply "per hour," and "deg." has been erroneously inserted in the place of "per cent." The latent heat of the steam was not taken into consideration, as the object was simply to compare the two methods.

NOTES ON ELECTRIC LIGHTING IN ITALY.

There are central stations at Milan, Rome, Naples, Turin, Venice, Palermo, Udine, Novara, Tivoli, Aosta, Terni, and other towns, the plant being chiefly by Edison and Ganz. Probably the largest central station is at Milan (Edison, Thomson-Houston and Ganz), but the one at the Anglo-Roman Gas Company's works in Rome will, when complete, be able to supply current for several hundred thousand incandescent lamps, and is equipped with Ganz alternating dynamos, coupled direct to Sulzer high-speed engines. The dynamos have fixed external armature coils and revolving internal magnets. They are self-exciting—that is, a portion of the armature current is commutated, and then led round the magnet coils in the usual way.

At Tivoli there is an installation on the Gaulard-Gibbs system. Each public lamp of 30 to 50 c.p. is fed by a special secondary generator, enclosed in a round metal case, above the glass globe, and at first sight the lantern might be mistaken for a Wenham lamp. It was originally intended to transmit the immense water-power running to waste at Tivoli to Rome on the A.T. system.

The central station at Milan is interesting, inasmuch as no particular "system" has been adapted to the exclusion of all others, though the supply company is called the "Società Generale Italiana Sistemà Edison." The total number of incandescents is nearly fifteen thousand. These are fed with direct current in the usual manner. The mains are those so generally adopted by the Edison people, and, in general, have given satisfaction. Considerable leakages occurred, however, at one period in their history, and a good length had to be taken up and relaid in troughs.

The main streets are lighted with Thomson-Houston lamps from the same station, and the famous "Galleria Vittorio Emanuele" is beautifully illuminated with Siemens arc lamps, which for steadiness (in this case) are unrivalled. Then, again, some lamps, which otherwise would be outside the reach of this station, are worked from Zipernowski transformers. Very few motors are at work in Milan.

Nearly all the principal railway stations, which are fine, modern, lofty buildings, with single-span roofs, are lighted with arc lamps. All these station installations have been carried out by Siemens and Halske, of Berlin. In the matter of sparking the dynamos resemble most other arc lighters.

Mill and factory lighting, the motive-power being principally water, is quite common, to the exclusion of oil, gas, and petroleum.

Good work has been done by the Edison Company, Sautter and Co., of Geneva, Crompton, W. H. Allen and Co., and the Oerlikon Company. The only Italian maker worth mentioning is the Tecnomasio Italiano.

A very large number of theatres have the electric light throughout. Perhaps the finest installation is that at the Scala Theatre in Milan, which consists of several thousand incandescent and a few arc lamps, the current being taken from the Edison station close by.

A few of the Lake Como steamboats, and most of the South American liners owned by the Società di Navigazione Italiana, are fitted throughout with the electric light.

Milan Cathedral is, perhaps, the only Italian place of worship which has taken to electricity, but, of course, candles are still retained on the altars.

Roughly speaking, there may be some 250,000 incandescent and 3,000 to 4,000 arc lamps at present at work in Italy, and considering that Italy is a comparatively poor nation, it is greatly to her credit. It is only about six years ago that electric lighting was introduced.

Very few motors are in use, but the Oerlikon Company is trying to cultivate this branch for itself, and has, it is said, contracted to transmit 250 h.p. a distance of about one-third mile, guaranteeing a very high commercial efficiency, something like 78 per cent. At Turin there were originally two *entrepreneurs*, but one has bought the other out, so that it is now practically one concern. At one station the Gaulard-Gibbs system, originally adopted, has been abandoned in favour of the Zipernowski transformer system, owing, so it is reported, to the unpleasant propensity of the secondary generators to make joules instead of watts. At the other stations everything went wrong at first, and the underground mains have had to be replaced by overhead wires on insulators. The dynamos were of "Edison make," and the high-speed engines were made by a local engineer, and it is said were not a complete success.

Generally speaking, electric lighting in Italy has been better done than in England, though nearly all the plant has been bought abroad.

The total number of lamps burning in England is doubtless far greater than in Italy, but then, industrially, Italy is a pigmy as yet, but making rapid strides.

There are several reasons why electric lighting has been so generally adopted in Italy, and are, briefly, the absence of "facilitating legislation," the costliness of gas, the abundance of water power, and last, though not least, the enthusiasm for electric lighting which permeates the Italian public.

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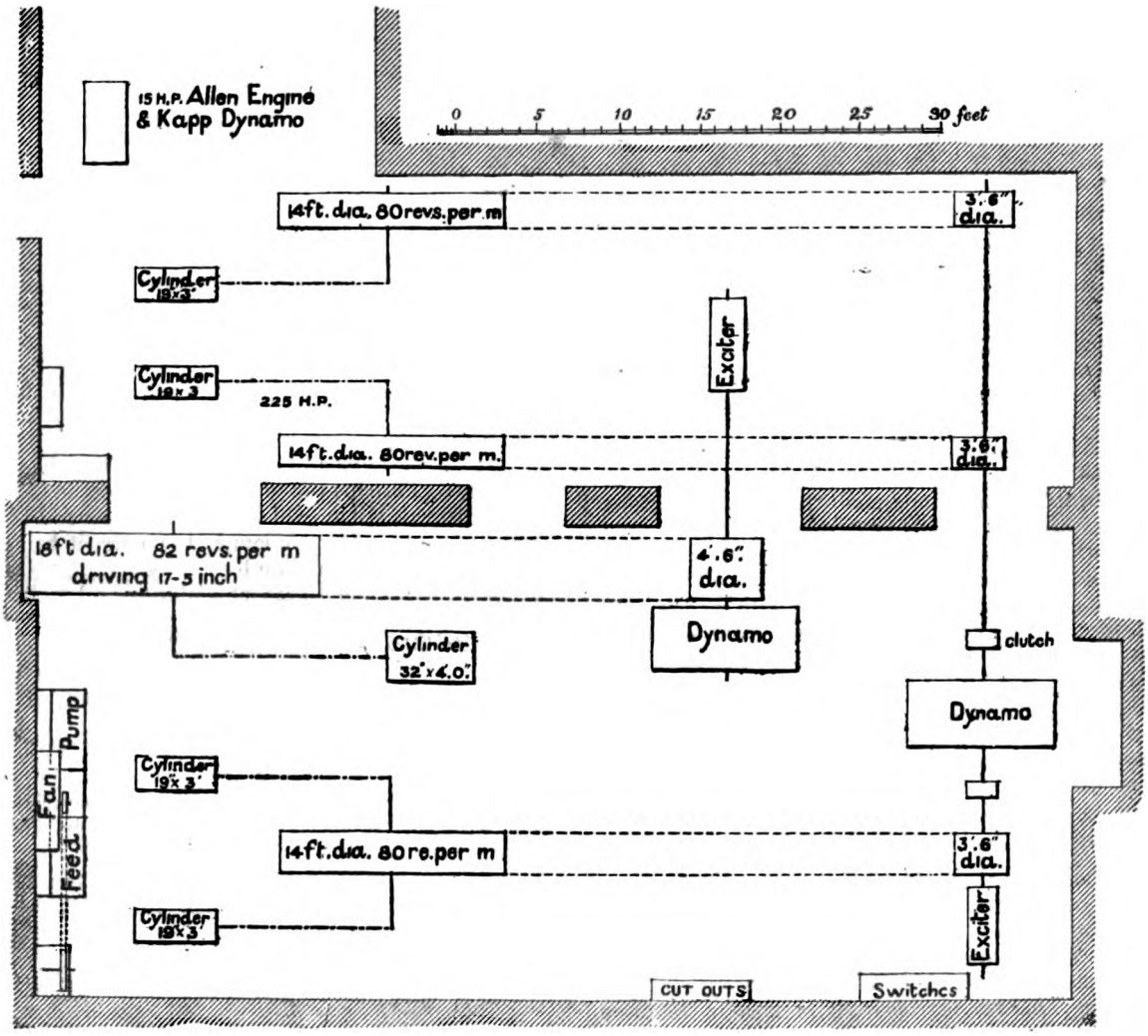
THE GROSVENOR GALLERY INSTALLATION.—II.

DETAILS.

We give this week an accurate plan—drawn to scale—of the arrangements of engines and dynamos at the Grosvenor, together with some details of the high-tension fuses used for the transformers. Six Babcock and Wilcox boilers are used for supply of steam, each of 150 h.p. nominal, capable of supplying double this amount. Two of these are always kept going, another pair with steam up ready for use if a fog comes on, and the third pair banked ready for firing. They are used turn and turn about, and all the six are used at night, for the demand is considerably greater than the supply, and 4,000 lamps are ready wired waiting for being connected. The original boilers that were first put in are not used, or only for occasional supply of one engine while the others are cleaning. The firing is all done by hand, and an ingenious method of storing is used, by which the coal is shot in above, and feeds downwards to the firemen as they shovel it out from below. Only forty tons of coal is stored, a constant supply being arranged for. Best Welsh coal is used (2ft. 9in. seam), about 24 tons a day on the average being consumed, falling in summer to 14 tons. A large water-heater is interposed to utilise the heat of escaping smoke and vapour.

The installation is now kept running night and day continually with the exception of a few hours on Sunday morning. There are 3,000 lamps now alight all night long. The primary current at 2,500 volts varies usually from 90 to 230 amperes, and half-hour readings are taken. The results are plotted out regularly in curves, showing the daily output. The measurements are taken by Sir W. Thomson's ampere balances, which are boxed in a case so that they cannot be touched, and are manipulated by strings from the outside. A Cardew voltmeter in the secondary circuit gives readings of the pressure, and this is always kept accurately to 100 volts.

It may be interesting to show the manner in which the engine power is regulated on a sudden increase of current. If a fog comes on, the demand may suddenly rise to 150 or 200 amperes in a quarter of an hour. Usually some indication can be seen from the outside of the approaching darkness. The governor-balls regulate for ordinary variations, but for great increase the link motion is varied, as shown in the accompanying diagram. A weight is attached to an arm which is connected to the link motion, and as this weight is shifted the lead of the valve is altered. When the demand exceeds the power of one engine, the men are told to be ready. A second engine is started, and when both are up to same speed—seen by the synchronous revolutions—the clutch is pressed over, and the second engine is thrown on.



Plan of the Grosvenor Gallery Installation.

The shaft of the dynamo is a double one, a solid shaft running inside a hollow one; by this means the further engine can be connected by the solid shaft, or the near engine by the hollow shaft, or both can be run together.

The Marshall engine is a two-cylinder coupled engine, 19in. cylinders, 36in. stroke, 80 revolutions per minute. It develops 500 h.p., and works at 120-130lb. pressure. The fly-wheel is 14ft diameter. Two more similar Marshall engines are run separately. These also have 14ft. fly-wheels.

The Corliss engine has 32in. cylinders, 4ft. stroke, working at 82 revolutions; it is fitted with reducing valve, and works at 70lb. pressure of steam. The fly-wheel is 18ft. diameter, and weighs 18 tons.

Two Ferranti dynamos are used. These are built to give 100 amperes each, and are driven at 290 revolutions. There are 80 magnets, in sets of 20 each. The bearings are on one side only, the armature being overhung. Siemens dynamos are used as exciters.

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The Allen engine, with Kapp dynamo, is used to light the engine-rooms when the main engines are stopped, and are also arranged so that the dynamo can be used as an additional exciter if either of the others went wrong.

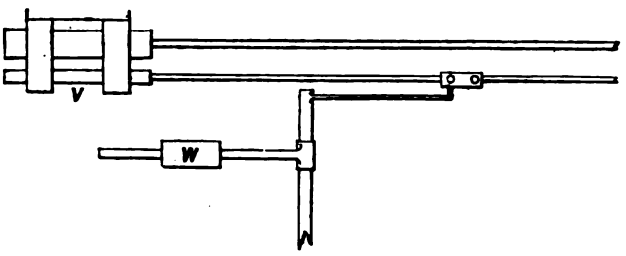
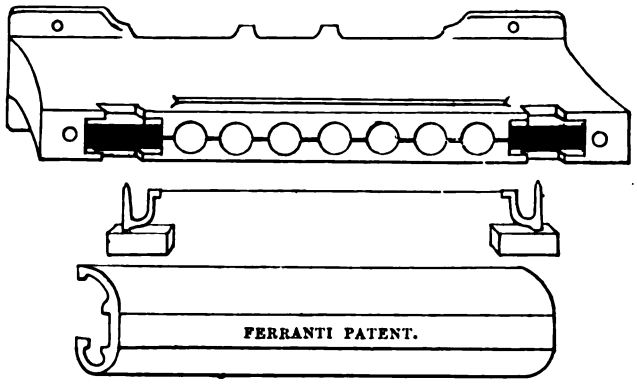


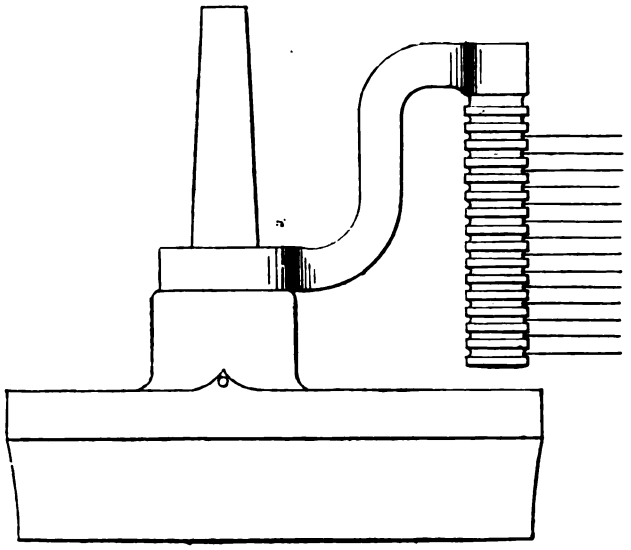
Diagram of Link Motion.

A very complete system of Worthington pumps is used, both for feed water, for pumping out the bilge water and for the oil-tanks. The engine-room being much lower than the sewer, pipes have to be led from races under the engines to the sewer. Castor oil is used throughout, and is circulated by means of a system of pipes by means of the pump. Each bearing has its pipe, and the oil drains into a tank below, and is pumped from there through two strainers to the top tank. A small Tangye engine, on a pier of masonry overhead, drives the fan and feed pump. A barring engine is used to get the fly-wheel of the large engine over the dead centre.



High-tension Cut-out for Transformers.

The high-tension cut-outs now used on the circuit are shown in the illustration. A porcelain body, with main plugs separated by the space of a foot or so, has a number of holes intervening to break the arc. These holes are slotted, to allow the fuse wire to go in. The fuse wire itself,



Ferranti Plug for Main Cut-out.

for 30 lights, is no more than one strand of No. 40 copper wire. For 100 lights three strands are used. For the main fuses fourteen No. 30 strands are used, with a larger plug. The fuse wire is soldered to the two plugs, as shown; these are made with ebonite handles and can be slipped into their places, the fuse wire going into the slots. The fuse-box has a piece of half-inch rubber between it and the wall. The fuse-box is then covered with the sliding porcelain lid.

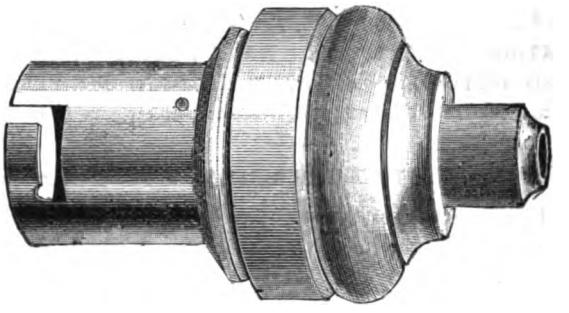
The primary current is led off first to a system of double-pole cut-outs of this nature, it then goes through the ampere-balance, and then to the main switches. These are very like an overhead system of pointsman's handles, and have a break of 2ft. The current is divided into five circuits, namely, St. James-street, Piccadilly and Bond-street, Regent-street, Oxford-street, and Park-lane. Any one of these circuits can be connected to any dynamo, and the act of throwing over causes only a momentary blinking of the lamps, hardly perceptible to the eye.

The engine-room is ventilated by a 72in. Blackman air propeller.

The machinery is under the management of Mr. Arthur J. Arnot and Mr. C. B. Brown, who take alternate day and night duty as engineers-in-charge. The outside department is under the control of Mr. H. Winter, who has long had the arrangement and connection of the high-tension overhead circuits. The whole of the present arrangements have been carried out by Mr. Ferranti, who, together with his assistant, Mr. Sparks, worked practically night and day to make the installation a success. Mr. Sparks has now the proud position of being Mr. Ferranti's partner.

NEW LAMPHOLDER.

We herewith illustrate a new design of lampholder introduced by Messrs. Appleton, Burbey, and Williamson,



of Queen Victoria-street. The material used in this holder is china, combining both a lampholder and shade-carrier. The form adopted here is the cap-holder, and, of course, the design can be varied to any extent. The use of china in electric fittings is increasing to a very large extent.

CORRESPONDENCE.

BANK OF ENGLAND ELECTRIC LIGHT.

To the Editor of The Electrical Engineer.

Sir,—As we hear that a report has been circulated in the City with reference to the above installation which may be prejudicial to electric lighting interests, we shall be glad if you can find space for a short explanation of the facts.

We are pleased to say there is not the slightest foundation for the statement that the Bank of England are discontinuing the use of the electric light—in fact, we are at this moment engaged in fixing two large gas-engines to supplement the 50 h.p. steam-engine, which has run without a hitch of any kind from the moment it was started. Possibly the rumour has originated through the temporary cessation of the light in the drawing office, where it has been found necessary to rearrange the early installation put down by another company some years ago, but we shall have this ready for use again shortly, and in the meantime we are pleased to notice that the short compulsory return to gas is by no means appreciated by the bank staff.—Yours, &c.,

Drake and Gorham.

2, Prince's-mansions, Victoria-street,
London, S.W.

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Vol. I., new series, of "THE ELECTRICAL ENGINEER" (Vol. IX., old series) is now ready, and can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

DIRECTORS' DANGERS.

The judgment of Mr. Justice Kay in regard to the liability of directors is of the greatest importance. Nowadays the greater proportion of limited liability companies are deliberately promoted for the express purpose of getting money from the public into the pockets of promoters. This might be tolerated, because the promoter, like every other worker, should be paid his hire. It is when the hire becomes the principal amount, and not the mere percentage for work done, that the necessity for grumbling comes in. After the promoter comes the directors, of the majority of whom it may safely be said that they know their way about. Before, however, any further reference is made to promoters or directors, let us acknowledge that, were it not for these men, a large amount of business that is done would be lost to the country. Even the wiliest and shadiest of the money suckers contribute more or less to the aggregate benefit of the community. They are compelled to be continually on the look out for something, be it mine, manufacture, or patent, that will form a good title for a prospectus, and undoubtedly sometimes they do ferret out a good sound base upon which is built a flourishing business. Were this not so, the business of promoting would soon become a dismal failure. If the truth must be told, we hold some of these men to be hard working enough to deserve a better fate, and it seems a pity their energies are not directed towards a better object. A company promoter is externally the most sanguine individual under the sun. His latest craze is, according to his convictions so energetically propounded, sure to lead to fortune, and no doubt he is in the majority of cases correct. The misfortune is that following his advice does not lead to the fortune of those who follow it, though it may have some effect upon the fortune of the adviser. It is pretty evident that where there are losers there are also gainers. The game of the city is to find large numbers who will tempt the loss of a little, and tempt it often, to the benefit of the few who pull the strings. So far as electrical matters are concerned, the early eighties saw the introduction of new applications of science, and these applications formed a happy hunting ground for promoters. Fortunes were quickly made, and of course lost. Among other companies floated, with no prospect of success as promoted, was the Faure Electric Accumulator Company. Although one or two technical papers tried to stem the torrent of madness that seized upon speculators, and suggested caution, the advice fell flat, and men rushed to their ruin. The game was not fair. On the one hand were the promoters, who knew nothing and cared less of the

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merits of the patents they bought and sold, but who had a very definite object—in being paid for the work of promotion; and on the other hand was a gullible public, whose state of ignorance was even worse than that of their antagonists, and made them the more ready for the gamble, because of the unknown quantity existing in the gamble. There is a statement we should like to make here, and which will to some extent lessen the enormity of the stupidity shown by the general public in those days. What was done then can be done now, and will be done if the chance to make money by it occurs. There is no difficulty at all in getting from men eminent in science, certificates as to the value of this or that patent, which in the hands of unscrupulous men can be put before the ignorant to mean what the writers never intended they should mean. Further, there are financial and other papers belonging to company mongers, whose utterances can be regulated according to the demand required. Thus, again, the game is unfair. The very men who promote the companies have the scribes in their pay, who should be above suspicion. The damage is done as much by acts of omission as by acts of commission. Who are directors? They may be classified in various ways, but for our purpose we will divide them into two classes: (1) Those who purchase shares legitimately; (2) those who have shares given them to qualify, and are merely creatures of the promoters. No doubt in the earlier days of the electric light boom it was comparatively easy to get men of the first of these classes, and it must be assumed that the directors of the Faure Company were such men. This being so, it was all the more easy for them to be led by designing men, and undoubtedly they were more or less led to carry out transactions which they would now hesitate in doing. The Faure Company is being wound up, and its directors have been proceeded against upon two counts—one connected with countenancing the transfer of shares, the other the paying of brokerage. As regards the former, Mr. Justice Kay holds the directors blameless, or, if not exactly blameless, at least guiltless; while on the latter he has decided against them, and they will have to refund a large sum of money held not to have been a legitimate payment by them on behalf of the company. One gentleman, who was not a director at the time of the transaction, of course cannot be held liable, while the principal, who was really at the bottom of the whole affair, has long since become bankrupt, so the penalty will fall somewhat heavily on the remaining directors. Our financial contemporary, the *Financial News*, writing upon this question yesterday, decides that Mr. Justice Kay's decision ought to have been the other way about—against the directors on the transfer of shares, and for the directors on the paying of brokerage. On this point, however, we will permit our contemporary to speak for itself. It says: "In the year 1882, Philippart, a Belgian adventurer of shady antecedents, brought over to London an invention which proved quite as unsatisfactory as himself. Our readers may remember its being puffed and trumpeted all over the country as the Faure Accumulator, which was going to make electricity easier to carry about than milk or muffins. In those days no electric invention was worth less than a round million sterling, and that was the modest price Philippart set on his accumulator. He selected his directors, formed his company, and tried to issue his shares in the gay and festive manner of the period. A market had to be made for them, and that is not a missionary operation. The benevolent jobber has to get his little pull, and the philanthropic broker looks for his little commission. As a rule, promoters have grace enough to keep their thumb on these domestic arrangements. They fix them up beforehand in their back parlours, and do not trouble subscribers with private details which might cause heart-burning. But the blustering Philippart disdained any such concealment. He was greedy, even for a promoter. Not only would he have his million sterling, but he left the payment of commissions and perquisites to the company. The rush for Faure Accumulator shares did not quite fulfil his expectations, and after the allotment a considerable number were left on hand. Philippart, who was a professional expert in French methods of finance, wanted these shares 'to play with,' as one of our own promoting luminaries used to call a process which has other names."

The moral of the tale is clear—promoters are selfish and want to get all they can, but at times they go too far and the law retaliates. Directors, again, are too ignorant or too much in the hands of the wire-pullers, and in an unlucky moment pass legal bounds, and become amenable to the law. Every new company that is formed should be closely watched, its directors should be known to be above suspicion, and known also to have a personal stake in the welfare of the company.

ST. JAMES' ELECTRIC LIGHT COMPANY.

PRELIMINARY NOTICE.

Among the various central stations now being installed in London, the St. James' occupies an exceedingly good position. In the midst of clubland, the demand should be, and no doubt will be, perfectly satisfactory to the shareholders. We illustrate on next page a plan of the station, which practically shows the arrangement of machinery adopted. The building has been designed specially for this work by Mr. R. A. Came, of Mecklenburg-square The engine and dynamo room is underground, the floor above being utilised as stables, and the upper floor as offices. The dynamos to be used are of a new type constructed by Messrs. Latimer Clark, Muirhead, and Co., which firm has in hand the contract for the installation. The dynamos will be driven by Willans engines, and we

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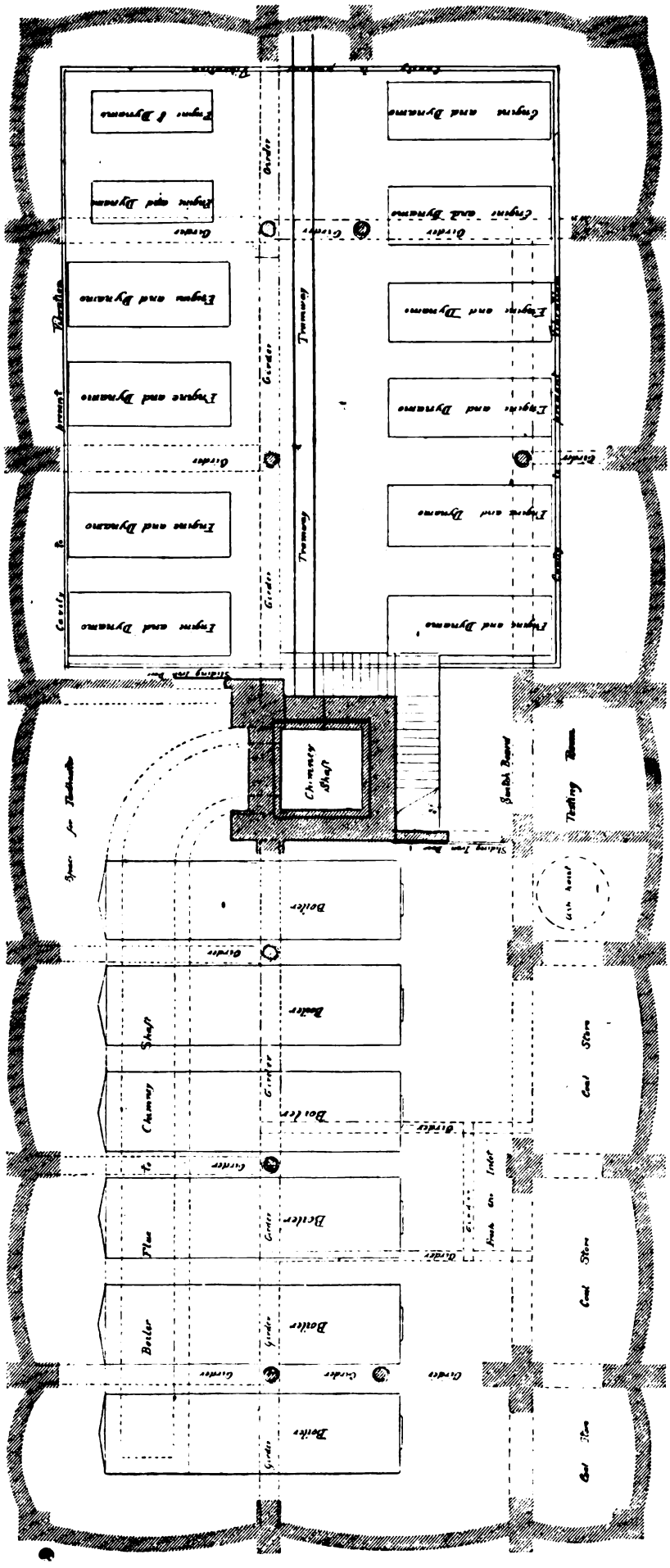
believe steam for them will be generated by Davey, Paxman, and Co.'s boilers. In order to prevent, as far as possible, any external vibration, the dynamos are fixed upon what may be termed a substantially built pier, surrounded by a cavity to keep it from contact with surrounding buildings. The station is designed for 20,000 lights, of which 5,000 will be run from the commencement. The mains are to be in conduits underground.


Chimney Shaft
Boiler
Boiler
Boiler
Boiler
Boiler
Boiler
Coal Store
Coal Store
Coal Store
Engine and Dynamo
Engine and Dynamo
Engine and Dynamo
Engine and Dynamo
Engine and Dynamo
Engine and Dynamo
Engine and Dynamo
Engine and Dynamo
Engine and Dynamo
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Girder
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EDDY'S ELECTRIC MEASURING INSTRUMENT.

Electric measuring instruments in which iron or steel is employed, upon whose magnetic strength the indications of the instrument depend, are open to the objection that the magnetic qualities of the iron and steel are liable to vary, and hence to effect wrong indications of the instrument after the lapse of time. In order to avoid the use of magnetic metal in the construction of electric measuring instruments, Mr. Arthur H. Eddy, of Hartford, Conn., has recently devised a novel form of instrument whose action is based upon the mutual attraction set up between the convolutions of a coil of wire by the passage of a current through the coil, so that a coil whose convolutions are free to move with the passage of current contracts in axial length; and the movement thus produced is communicated to an index which travels over a scale, and the effect is thus indicated directly in amperes or volts.

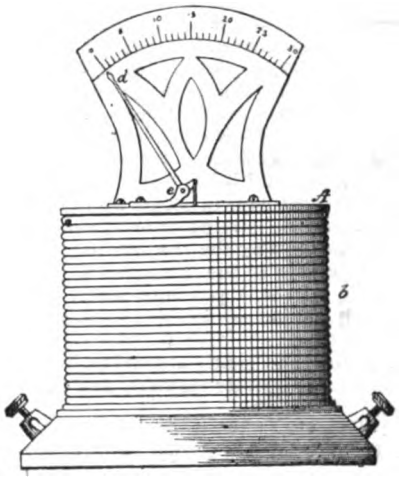

FIG. 1.

The accompanying engraving, Fig. 1, shows the instrument in perspective, and Fig. 2 is a section of the same, showing the arrangement of the spirals. A brass bobbin, A, is made with comparatively large bore, and is wound with wire, *b*, to suitable depth. In the interior there is placed a double spiral of wire, *c*, wound so that one spiral is inside the other, the winding being such that the current enters one spiral at the bottom or fixed end, ascends

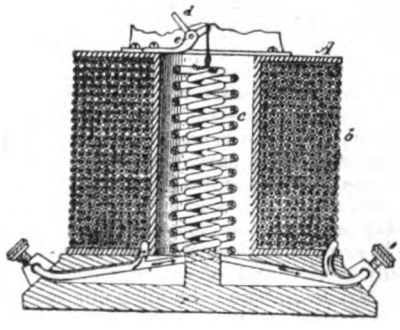

FIG. 2.

to the top, and then returns to the bottom through the other spiral, the direction of current being parallel throughout. The two spirals, *c*, are at the upper or free end connected with the index or pointer, *d*, which is pivoted in a bearing, *e*, on the spool, A, and has its outer end moving over a scale.

Obviously, when current is passing through the spirals, *c*, the various convolutions will be mutually attracted, and the lower ends being fixed to the base the mutual attraction causes a decided shortening of the axial length of the spirals, *c*, which shortening movement causes movement of the pointer. The extent of movement of the pointer over the scale can be made greater by increasing the ratio between the arms of the lever system formed by the pivoted index, *d*.

The relative movement of the spiral for given increments or decrements of current strength or potential will be proportional within certain limits; but the instrument is designed to be graduated by reference to a standard, after which its readings will be constant.

The movement obtained can be still further increased by sending the current also through the external or field coils, *b*, in such direction as to make the total effect cumulative. The coil or spiral, *c*, must, of course, be selected with a view to a definite range or current capacity, and Mr. Eddy keeps far within the limits which might be placed by the modulus of elasticity of the metal employed and the heat produced by the current. To reduce the latter to the lowest possible degree, the coils, *b* and *c*, are so connected that they shall be in multiple arc, so that a comparatively small wire can be used for the latter, and the number of convolutions made considerable.—*Electrical World.*

ELECTRIC TRAMWAYS.

At the seventh annual meeting of the American Street Railway Association, held at Willard's Hotel, Washington, a long discussion took place upon the use of electricity for traction purposes upon such railways. It is well known that at present we are far behindhand in England in this class of work compared with America, and it is to the work of the users of electric traction in America that we must look at present for information. Last week we reported the trial of an electric tramcar at Birmingham, and mentioned that the system was a combination of Julien's and Messrs. Elwell-Parker. It will be seen from the report that we give herewith that the general manager of the Julien Company at New York opened the discussion at the meeting we refer to.

Mr. W. BRACKEN, general manager, Julien Electric Company, New York City: Mr. President and gentlemen, I have hesitated to undertake the preface to this discussion. This is always the most disagreeable part, like the preface to a book. It is the more difficult on the present occasion, simply because I do not profess to be an electrician; it is only a few years since I had the honour to be ranked among the gentlemen who represent your great industry. I am one of that dangerous class of men known as a Philadelphia lawyer, who, in a moment of folly, left his profession some two and a half years ago, and directed his attention to electric traction. I am not able to discuss the subject by the use of technical terms, which men skilled in the science are accustomed to use; neither am I a mechanic, nor do I know anything about the street railway industry. I have had the opportunity of devoting two and a half years in the capacity of an officer of a company engaged in electric traction, the Julien Electric Company, New York; and I came on here to be a looker-on in the convention rather than with any hope that I should have the privilege of addressing you. I trust, therefore, you will extend me your indulgence if I make statements which your practical sense may deem to be impracticable, or not to the point. I think it a very auspicious thing that the electric traction men, and the hard-headed, practical, common-sense, intelligent street railroad men of this country should meet as they do to-day and exchange views. I think it shows that the electric traction men deem it necessary to co-operate with the street railway men; and I trust that the street railway men will regard it in the same light. There has been a great deal of misapprehension, I think, on both sides in relation to the application of electricity as a motive power. I think the electricians have led the street railway men to expect too much, and I am afraid that on that account, and for other reasons, the street railway men have been too exacting with electricians. Of course, it is natural in an industry entirely new, like that of electricity — a science that has certainly until very recent years been regarded as an occult science—that a certain air of mystery should surround it, and have two effects—viz., that of making people who are naturally very sanguine to expect too much; and to lead people who are accustomed to spy into abuses, to regard it with some degree of scepticism. But, gentlemen, there is nothing mysterious about electricity; electricity is energy just as steam is. It is necessary to consume coal, or some other material, in order to develop electricity. It is handled just in the same way that steam is handled; and when you direct your attention to it, if you will not be afraid to look into it and study what you may deem its mysteries, you will be surprised to find how simple it is, and how docile. I am not one of those over-sanguine people who think that electrical traction is going to supersede every other method of traction; and neither am I sufficiently conceited to imagine that storage battery electrical traction, which I represent, is going to supersede every other method of electrical traction. I think there is a sufficient field for all, and the sooner we come to recognise

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this and pull together in harmony and exchange of views, as to the best methods of applying our systems, the sooner we will succeed.

No man will say, no matter how sanguine he may be, that the president of this association, Mr. Holmes, would dream for a moment of exchanging what, from his description and what I have heard from others, is a magnificent system of cable traction, for any system of existing electrical traction at the present day. In the economy of his system, in the method and manner in which it works, I should hardly deem that it would be judicious for him to do so. I cannot see myself any difference in starting from a central station and moving a cable, which gripped on to will move a car, and running that same energy through a wire which grips the car instead of being gripped, and takes it to the same destination, provided the economy in both should be the same. I will not discuss this matter, however, as I am here to discuss the merits of the storage battery system of electric motive power, and if I may be indulged I will tell you about it.

Two years ago, and over, I was in the city of Brussels on professional business, and on coming out of my hotel one morning I saw a car moving along the street, neither overhead wire, nor cable, nor horses, nor any indications of the means by which the car moved. I got on the car, and was told it was run by accumulators—storage batteries. I knew nothing of the system, and took an interest in it, and saw the counsel of the road that was engaged in that method of traction, who explained to me all that he knew about it. I came back very enthusiastic over what I had seen. The result was we made arrangements to apply it here. I got Messrs. Julien to forward us a car to New York, in order to put it in service, and demonstrate what could be done with it. You may not all know that the shortest curve in Brussels is 42ft. radius; we have to describe a curve on the Fourth-avenue road, New York City, of 21ft. radius, and up hill at that. Consequently, the car that Messrs. Julien sent to us was ill-adapted to do the rough, hard service that a street-car in this country is expected to perform. We not only had those difficulties to encounter, but the methods of producing the machinery, especially the storage batteries, at that time, although it is only two and a half years ago, certainly seemed to us, and proved afterwards, in the light of experience, to be very crude. Messrs. Julien sent over to us the most improved methods of manufacturing storage batteries; the furnaces, moulds, and all the adjuncts they had in Brussels were reproduced and sent here, accompanied by an electrician, who was supposed to be skilled in the mysterious art of making a storage battery. We went to work; and, fortunately, the company had secured the services of bright intelligent American mechanics and skilled men, especially a chemist (which is invaluable in the storage battery manufacture), and we soon discovered the crudeness of the art, although we had the best methods and appliances that were to be found in England or in Europe. From what was deemed, and has been deemed, and is generally deemed as a forbidden thing in storage battery traction—that is, the cost of the storage battery and its life, which have been considered too expensive for general adoption—we have reached the point where we are prepared to set down at the doors of any street-railway man, a factor of force in storage batteries more cheaply than he could secure his horses, and we will produce that and supply the force more cheaply than he can maintain his horses. The storage battery, if I may say so, is nothing mysterious; it simply consists of plates made of lead or other metal; usually of platinum, of which you must all have heard. We treat it with a chemical suffusion which changes the properties of the metal, and makes it a receptacle for electrical energy. In order to fill these plates with this suffusion or mixture, we had to employ a large number of men. Each man had before him a small piece of board on which he had instruments or cups for measuring the quantity of mixture to put on each plate, and that was spread on with a trowel, and no matter how diligently the man worked, he could not make more than sixty plates a day. That is the method in Europe to-day. You can imagine how expensive that was. Our Mr. Henry G. Morris so improved this that two girls are able to make more batteries to-day than fifty men were able to make a year ago, and they are more uniform and better in every respect; so that instead of charging 11dols. a cell, as we were obliged to a year ago, if you were to offer us, say, 6dols. a cell, or even less, you would be in danger of being taken up. Of course, we had a great deal to contend with, owing to the ignorance of men whom we had to employ in this storage battery manufacture. It is very easy to drill men in matters of horse traction, or even in cable traction; you can secure a number of men capable of handling your cars or engines at the central station. But we were engaged in an industry that was entirely new, unknown; there was not a factory in this country when we began manufacturing storage batteries. Mr. Brush had played with them sometimes, but never had produced commercial results. I want to show you what this country can do with an industry like this. Although we run our factory night and day in Camden, New Jersey, we are very much behind in our orders. We are lighting the cars of a large number of railroads; among others, the Boston and Albany, the Pullman vestibule cars, and a large number of cars on the Pennsylvania Railroad; also the watch factory at Waltham, Massachusetts, is lighted by the Julien storage system. I am not saying this, gentlemen, in order to extol the company I am connected with, but simply to show you what progress has been made in this industry.

People ask, why are you not running more cars? The chief reason is because we have been unable to find men who were skilled in the knowledge of handling our batteries and other electrical apparatus. We want to send cars on the streets that will take care of themselves, and carry passengers, and stop, and start, and get back to the carhouse, and this requires a great deal more care than is commonly understood. We have started to do the most difficult thing that has been done or attempted. We intend to do the thing which calls for the highest degree of electrical skill. We have a great deal of respect for gentlemen who will attach a car to a current on an overhead wire, or a conduit; but it requires a great deal of care and industry to take a car that is propelled by its own energy, and which must take care of itself throughout, and must get back, on a journey of 12 miles, without any but necessary stops in a crowded street, and without interfering with public traffic, it is no easy matter to attain, and to do it economically. We are attempting to do something that has not hitherto been undertaken; certainly never with a fair degree of success as the result. I will say this, that never has a car of the weight which is now run on Fourth-avenue and Madison-avenue, New York—an 18ft. car, with large platforms, and capable of carrying, when crowded, some 70 or 75 people—been run successfully by electricity. We put one car in service on the 17th of September, and it has been running on that line every day up to the present day, in actual service carrying passengers, and in that time we have never had an accident whereby we have stopped traffic or whereby the car has been disabled, and not been able to return to the station with its passengers just as it started out. I thank you very much, gentlemen, for the indulgence which you have extended to me, and hope I have not intruded on your time.

Mr. HOLMES: Before the gentleman takes his seat I would like to ask him if the cars operate regularly day after day carrying passengers.

Mr. BRACKEN: They do.

Mr. HOLMES: On how large a scale? Please give us all the information you can.

Mr. BRACKEN: In relation to your question, Mr. President, as to what progress in operation we have made, I would say that the car we received from Mr. Julien some two years ago was entirely unadapted to the work required of the American street car. The motors were not sufficiently powerful. They took the car along, but just as a single horse might take it up a heavy grade—with a great deal of difficulty. We were thus compelled at once to adapt our car to the work required. We had a great deal of correspondence with street car gentlemen throughout the country concerning our system, and desiring us to make guarantees; but we were not in a position to do it at the time. We intended to start out and exhibit ourselves for our own benefit on a street that presented heavy grades (as Fourth-avenue and Madison-avenue, New York, do), in a crowded city, like New York; and we determined to put on ten cars, in order that the street railway men of America might inspect our system for themselves. On the 17th of September we put this car on—car number one—and every day since that time, with the exception of Sundays, that car has been running in regular passenger service, carrying passengers. Car number three was put in service but two or three days ago. Car number two will be in service to-day; certainly by the time any of you gentlemen may be passing through New York it will be in service, so that this week there will be three cars in actual daily service, and, of course, we shall follow them up day by day. Mr. Brill, who is building our cars, says that the remaining seven cars will be forwarded to us as we are ready for them. We have suffered under some disadvantage in our present undertaking, in the fact that the space is small. We have found it no small task to put in the space which you would allow to four horses sufficient batteries to run ten cars. We are compelled to put enough batteries to run ten 18ft. cars in that small space, and you can imagine that we have difficulties to contend with. We cannot rush into a big lot and take all the space we require. Mr. Vanderbilt places at our disposal a portion of his stable at Eighty-sixth-street, and we must be content with that?

Mr. HOLMES: What rate of speed do you make?

Mr. BRACKEN: To say we could make any rate of speed would be exaggeration; but the present car is geared to run about ten or twelve miles an hour, maximum.

Mr. HOLMES: Does it actually do that?

Mr. BRACKEN: It actually does that. I think there are a number of gentlemen in the room who know it makes that rate. You can see that there is no object in the present instance in putting a car on Fourth-avenue which would not make seven miles an hour. If you run at less speed than that, the expenditure or waste of force would be greater, in consequence of the

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machine being geared to make a high rate of speed. We geared car number three up to make seventeen or eighteen miles an hour. We do not want it to do it, but we were compelled to. I should say that with a storage battery car properly geared you could attain a speed of twenty miles an hour.

Mr. HOLMES: Can that rate of speed be maintained for any length of time?

Mr. BRACKEN: Yes, sir; it can be maintained throughout. It is merely a matter of energy; you have it there; it is stored in your battery, and you can apply it *ad libitum* until exhausted. We put it in our batteries; we have enough energy in the battery to take the car about 23 miles. Theoretically we ought to go 40 miles; but you cannot safely do it in the city of New York. You may carry 250 passengers on the trip, or you may carry only twenty; you cannot afford to run any risks, because your car must get back. The result is that we go to work and take out our batteries at the end of each trip, and place them in the charging circuits in connection with the dynamo, and we get sufficient energy while the car is out with the other set. The battery that has just made the trip is taken out and the charged battery put in, and the battery taken out is charged sufficiently while the car is making a round trip to the city hall and back, about twelve miles, and taking about two hours, so that we get along with two sets of batteries.

Mr. AUGUSTINE W. WRIGHT: Mr. President, I would like to ask the gentleman what is the weight of the battery and car, exclusive of lead; and how long it takes to charge the batteries, and what is the length of service when they are charged. The gentleman has anticipated the question as to the amount of space required.

Mr. BRACKEN: The weight of a 16ft. car, which is the kind that will be in universal demand, and which we expect to equip, exclusive of passengers, will be about six and one-half tons. The No. 3 car, which is a 16ft. car, in which Mr. Julien has put a great deal of iron, in order to brace it, weighs nearly seven tons. Our 18ft. car weighs over eight tons, exclusive of passengers, with the battery, motor, and everything else. This car has double trucks, and eight wheels. The weight of the battery is over two tons. A single-truck car, like No. 3 car, would weigh about six and one-half tons.

Mr. EDWARD J. LAWLESS: There are several gentlemen here, as well as myself, who are very desirous of investigating this question thoroughly, with a view to adopting electricity in our own cities. How many miles—I mean now for actual running purposes—how many miles will one of these storage battery cars run without any recharging?

Mr. BRACKEN: It depends on the track and grade. I should say on a level road that a battery ought to run 40 miles without recharging. The battery contains about 60 or 70 e.h.p. hours when it is charged, and on a level, with a car of that kind, with an economic motor, such as are now used, it would propel the car on the level with a little over 1 h.p. expenditure per mile. You have so many e.h.p. hours in your battery.

Mr. LAWLESS: So that a car would have to be charged twice a day in order to do a day's work?

Mr. BRACKEN: It depends on the number of miles.

Mr. LAWLESS: The financial result is what we want, principally; can you give me any idea of what the cost of these cars placed on the road, ready for work, how much will it come to?

Mr. BRACKEN: It ought not to exceed 4,000dols.

Mr. LAWLESS: Would that include the duplicate cells?

Mr. BRACKEN: Two cells, two motors, and the car complete.

Mr. LAWLESS: How long do you think it would take to recharge one of these cells? Suppose we had to take it in, how long would it take to charge the set—that is, to put the car out for the purpose of running again?

Mr. BRACKEN: Just the time it takes to change the horses. Perhaps two minutes.

Mr. LAWLESS: How long would it take to recharge the cells?

Mr. BRACKEN: About six hours.

Mr. LAWLESS: How many men would it take to recharge them?

Mr. BRACKEN: One man in charge of the dynamo. One man in charge of the whole station.

Mr. LAWLESS: For, say, an equipment of about twenty or thirty cars, how many generators would you require in the power house to charge the cells?

Mr. BRACKEN: Eight h.p. for each 16ft. car.

Mr. LAWLESS: What is the lifetime of the cells?

Mr. BRACKEN: As to the lifetime of the cells, I would require to answer the question fully. Any man who thinks he knows exactly the lifetime of a battery knows more than I do. There are some men who maintain they do. I do not know, but I can say this, that I know of storage batteries that have been in use over two years, subjected to hard work, that to-day are in service, and doing good service. I will instance the Pennsylvania Railroad, to whom we sold batteries on June 28, 1886, and if there is any gentleman who is interested in applying to the Pennsylvania Railroad, they will inform him that these batteries have been in constant use since, two years, and not a single cell exchanged. The executive mansion at Albany is lighted by our batteries; they have there over two hundred lights in Governor Hill's executive residence, and we are informed by the gentleman in charge, whom I have never seen—entirely disconnected with us—that he has not changed a single cell in that time. I will go further and state that if the batteries will last only six months, as I believe the most sceptical will admit they do—I do not care if they last only three months—it will be cheaper than horses.

Mr. LAWLESS: Mr. President, what I want to get at is the financial result, so as to report to my company whether it would be a financial success for them to adopt electricity.

Mr. HOLMES: I am ready to equip ten lines to-morrow if I can get the right sort of thing to do it with. I want to know fully about it, and all these gentlemen do.

Mr. HURT, of Washington: I would like to ask the gentleman the cost of renewal of the batteries?

Mr. BRACKEN: Two men, to whom you will pay 1dol. 75 cents or 2dols. a day, and two girls and a machine that will cost 500dols., with one-third of the original cost of the battery, will in four days replace the battery. In Camden we pay 40 cents a day to the two girls. It is heartless, we know, but then we are trying to protect them all the same (laughter). Say that the cells cost 5dols. apiece, the material of your cell, with the exception of the active matter, is never destroyed, and is perfectly good to cast over and remake; and by putting your elements into the solution, in four days you can reproduce the battery of the car.

Mr. KEEFER, Ottawa: The cost of the material in reproduction?

Mr. BRACKEN: It varies; some people buy the lead cheaper at one time than at another; it may be cheap now and next week it may be dear. Assuming, however, that the active material and the lead itself would amount to five cents a pound, for two tons that would be 200dols. for the material in the whole battery.

Mr. RICHARDSON, of Brooklyn: Do you use copper?

Mr. BRACKEN: Nothing but lead. Lead is the chief ingredient; 94½ per cent.

Mr. EPPLEY, of Orange: I would like to ask the gentleman what is the cost of the motive-power equipment, exclusive of the car? He said the car cost 4,000dols. complete. I want to get at the cost of putting the machine under a new car.

Mr. BRACKEN: I assume the car body costs 1,000dols.; that makes the other equipment 3,000. If you please, I will make one statement more in relation to the Fourth-avenue car. I went over the line in an electric car with an officer of the New York Central Road the other day just about dark. This is simply an illustration of the effect it produces. It is lighted with 16 c.p. incandescent lights. We got off at Seventy-first-street to return to our hotel, and took one of the horse cars with dim, straggling lights, one at either end, and the officer looked about, and he said, "Skitt, this will never do; we must have electric lighting" (laughter).

(To be continued.)

BRITISH ASSOCIATION, BATH.*

ON THE POLARISATION OF SMALL ELECTRODES IN DILUTE SULPHURIC ACID.

BY DR. FRANZ RICHARZ, OF BERLIN.

I examined which greatest value the E.M.F. of galvanic polarisation possesses at platinum wires of very small surface in the electrolysis of dilute sulphuric acid.

I. Previous experiments by Buff (Pogg. "Ann." 130, p. 341, 1867, and Fromme (Wied. "Ann." 33, p. 80, 1888) have given under those conditions 3.3 and 4·3 Daniells for the maximum. In these experiments the polarisation is calculated from measurements of the intensity of the galvanic current during the electrolysis, tacitly assuming that the resistance of the decomposition-cell is independent of the intensity of the galvanic current. The correctness of this supposition has not been proved. I tried experiments by similar methods, and obtained yet greater values of the polarisation; it was calculated a current-density of 12 amperes per square centimetre as 4·4 Daniells, and increased more and more with increasing intensity of the galvanic current. It is very improbable that this can be right. By supposing, however, that the resistance of the decomposition-cell is not independent of the intensity, but decreases in a fixed manner with increasing intensity, the calculation of the same experiments gives small and constant values of polarisation.

II. Such a decrease of the resistance of a decomposition-cell with very thin platinum wires with increasing intensity may be inferred from the following reasons:

(*a*) The resistance of the cell has its principal seat in the fluid layers immediately near the electrodes. These layers, however, grow warmer the greater the intensity is, and the warmer these layers are, the less their resistance will be. The heating so produced can be very great. Calculation shows for my experiments that (loss of heat not being taken into account), at the greatest intensities employed (*circa* one ampere), the fluid immediately at the electrode is heated to boiling heat after a seventh of a second. The heating is proved experimentally by the appearance of a phenomenon very similar to Leidenfrost's phenomenon, and depending on the formation of a steam-case round the electrode.

* Communicated by the Secretary of the Electrolysis Committee.

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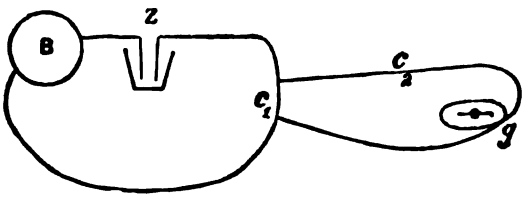
(*b*) With small intensities the evolution of gas does not take place over the whole wire, but only on some spots of it; with the least intensities only on one spot.

(*c*) The diffusion in the fluid of the gases evolved by electrolysis corresponds to a "transition-resistance" (H. von Helmholtz, "Sitsungsber. d. Berl. Akad." 1883, p. 664). That resistance must relatively be the more important as compared with the other effects in the cell, the smaller the latter are; therefore it must appear as a resistance increasing with decreasing intensity.

These three causes produce a considerable decrease of the resistance with increasing intensity. The hypothesis according to which the methods mentioned under I. gave such very high valves for the polarisation is thus not fulfilled.

III. I have made measurements of the polarisation of very thin platinum wires in sulphuric acid, a new method, which is independent



of the resistance of the decomposition-cell. The circuit of the galvanic current, which contains the polarising battery, B, and the cell, *z*, is closed by the first contact, c_1, of Helmholtz's pendulum-interrupter (Wied. "Electr." iv., p. 219, 227). A branch circuit proceeds from either side of c_1 to a galvanometer, *g*. This circuit included the second contact, c_2, of the pendulum-interrupter, and a very great resistance (40,000 Siemens units). While c_1 is closed, the current is very weak in the galvanometer. In the short time between the interruption of c_1 and c_2 a current, strong for the sensibility of the galvanometer, goes through it. The impact of the galvanic current is proportional to the E.M.F. of the battery minus the polarisation. From the deflection of the galvanometer I can calculate the mean value of the polarisation in the time between the interruptions of c_1 and c_2, and by diminishing this time more and more I can judge if the polarisation during this time has already decreased considerably. I shortened that time to 0·00059 second, and diminished the surface of the platina wires to 0 8 sq. mm., and increased the intensity at those electrodes to 0·4 ampere. The values of polarisation which I found were never greater than nearly 2·4 Daniells, and, taking account of the decrease of polarisation, its value before the interruption would amount to, at most, 2·5 Daniells. That is, the same maximum as was found for the polarisation also with large platinum plates in dilute sulphuric acid. Now, with thin wires a great deal of ozone, peroxide of hydrogen, and persulphuric acid is evolved at the anode; at plates only common oxygen. As the E.M.F. of polarisation has the same value in either case, it is to be concluded from the facts that the evolving of those hyper-oxides has no influence upon the polarisation; and, further, that the primary electrolytical process by which the strength of the polarisation is chiefly conditioned is the very same during the development of common oxygen as at the evolving O_3, H_2O_2 and $S_2O_8H_2$ from dilute sulphuric acid.

IV. The influence of the formation of $S_2O_8H_2$ on the polarisation may be judged, too, from the electromotive behaviour of platinum in $S_2O_8H_2$. I found the E.M.F.

$$Hg \mid Hg_2SO_4 \mid SO_4H_2aq \mid S_2O_8H_2aq \mid Pt = 0{\cdot}75 \text{ Dans.}$$
$$Zn \mid SO_4H_2aq \mid S_2O_8H_2aq \mid Pt = 2{\cdot}06 \text{ Dans.}$$

From which may be calculated

$$Pt \mid SO_4H_2aq \mid S_2O_8H_2 \mid Pt = 0{\cdot}61 \text{ Dan.}$$

In this last cell the process effected by the galvanic current is the reduction of the persulphuric acid, according to the formula

$$S_2O_8H_2aq = 2SO_4H_2aq + O.$$

Its heat of formation (Berthelot, "Compt. Rend.," 90, p. 331, 1880) is equivalent to 0·56 Daniell. It is to be concluded from the conformity of the found with the calculated value that the reduction of the persulphuric acid in that cell is a primary electrolytic process. Besides, it must seem very probable that the formation of $S_2O_8H_2$ at the anode, also corresponding to the inverse process, is a primary electrolytic process. To its chemical heat of formation a polarisation of the anode of 0·56 Dan. would correspond. Generally, however, neither the polarisation alone is given by the chemical heat, nor is $S_2O_8H_2$ alone formed under any circumstances at the anode.

LEGAL INTELLIGENCE.

FAURE ELECTRIC COMPANY.—LIABILITY OF DIRECTORS.

On Tuesday, in the Chancery Division of the High Court of Justice, Mr. Justice Kay delivered judgment on the summons taken out by the liquidator of the Faure Electric Accumulator Company, Limited, against the Directors.

Mr. Justice Kay: The liquidator of this company, which is being wound up in this court, has taken out the present summons against certain gentlemen, who were formerly directors of the company, under Section 165 of the Companies Act, 1862, seeking to make them personally liable for alleged misfeasance as such directors. No imputation whatever is made on the honesty or honourable conduct of any of these gentlemen; but it is alleged that they have committed breaches of trust in making certain payments out of the moneys of the company, and in permitting the transfer of certain of its shares. These questions involve the consideration of what is the position of the directors of a joint-stock company with respect to the capital of the company under its management. It has been said they are *quasi* trustees of the company. "In that and other respects they are to a certain extent trustees," Lord Justice Lindley says in his book on partnership. In the language of Lord Romilly, in the case of the York and New Midland Railway Company *v.* Hudson: "The directors are persons selected to manage the affairs of the company for the benefit of the shareholders. It is an office of trust which, if they undertake it, it is their duty to perform fully and entirely. They certainly are not trustees in the sense of these words as used with reference to an instrument of trust—such as a marriage settlement or will. One obvious distinction is that the property of the company is not legally vested in them. Another, and perhaps broader, distinction is that they are the managing agents of a trading association, and such control as they have over its property, and such powers as by the constitution of the company are vested in them, are confided to them for purposes widely different from those which exist in the case of such ordinary trusts as I have referred to, and which require that a larger discretion should be given to them. Perhaps the nearest analogy to their position would be that of managing agent of a mercantile house, to whom the control of its property and very large powers for the management of its business were confided. But there is no analogy which is absolutely perfect. Their position is peculiar, because of the very great extent of their powers and the absence of control, except by the action of the shareholders of the company. However, it is quite obvious that to apply to directors the strict rules of the Court of Chancery with respect to ordinary trustees might fetter their action to an extent which would be exceedingly disadvantageous to the company they represent." In the Forest of Dean Coal Mining Company (10th Chancery Division), Sir George Jessel, late Master of the Rolls, said: "Directors have sometimes been called trustees, or commercial trustees, and sometimes they have been called managing partners. It does not much matter what you call them so long as you understand what their true position is, which is that they are really commercial men, managing a trading concern for the benefit of themselves and of all the other shareholders in it. They are bound, no doubt, to use reasonable diligence, having regard to their position, though probably an ordinary director cannot be expected to devote as much time and attention to the business as the sole managing partner of an ordinary business." "They are, no doubt, trustees of assets which have come into their hands, or which are under their control, but they are not trustees of a debt due to the company. The company is the creditor, and, as I said before, they are only the managing partners." In Smith *v.* Anderson, 15th Chancery Division, Lord Justice James said: "The distinction between a director and a trustee is an essential distinction founded on the very nature of things. A trustee is a man who is the owner of the property, and deals with it as principal, as owner, and as master, subject only to an equitable obligation to account to some persons to whom he stands in the relation of trustee and who are his *cestuis que* trust. The same individual may fill the office of director and also be a trustee having property, but that is a rare, exceptional, and casual circumstance. The office of director is that of a paid servant of the company. A director never enters into a contract for himself, but he enters into contracts for his principal—that is, for the company of whom he is a director and for whom he is acting. He cannot sue on such contracts nor be sued on them unless he exceeds his authority. That seems to me to be the broad distinction between trustees and directors." If directors apply money of the company for purposes so outside its power that the company could not sanction such application, they may be made primarily liable as for a breach of trust. On the other hand, if they apply money of the company or exercise any of its powers in a manner which is not *ultra vires*, then a strong and clear case of misfeasance must be made out to render them liable. Lord Hatherley, in the case of the Overend and Gurney Company *v.* Gibbs, in Law Reports, 5th House of Lords, intimates that in such a case their conduct must amount to *crassa negligentia*. In Marzetti's case, 28th Weekly Reporter, a definite test is applied. Lord Justice James says: "A director should not be held liable upon any very strict rule, such as those, in my opinion, too strict rules which were laid down by the Court of Chancery to make unfortunate trustees liable. Directors are not to be made liable on those strict rules which have been applied to trustees"; and he intimates that the negligence for which a director should be held liable must be such as would make a managing director of a business liable to his employers. Lord Justice Brett says: "The director might be guilty of such negligence as would make him liable in an action. Mere imprudence is not such negligence, want of judgment is not; it must be such negligence as would make a man liable in point of law"; and with this Lord Justice Cotton concurs. This is the law that must be applied to the circumstances of this case.

The Faure Electric Accumulator Company was formed on May 13, 1882, for the purpose of making and carrying out an agreement for the purchase of certain patents, and carrying on the business of electricians and other matters The capital was £1,000,000, divided into 80,000 ordinary shares of £10 each and 200,000 deferred shares of £1 each. Article 92 authorised the directors, out of the funds of the company, to pay the necessary legal and other expenses of and incident to the promotion, formation, and registration of the company, and all other preliminary expenses of the company. Article 28 is: "No transfer of shares not being fully paid-up shall be registered unless and until the transferee is approved by the board of directors; and the board at their discretion may decline to register any transfer of shares upon which the company has a lien." On February 15, 1882, the company entered into an agreement for the purchase of certain patents under which payments had to be made in shares of the company; 20,108 shares of £10 each were subsequently allotted to the general public, and in this manner all the original £10 share capital was issued except about 20,000 shares. It appears that the company got into litigation in May of that year with another

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company, who they alleged were infringing their powers. M. Philippart, who, it seems, was very familiar with the working of these patents, attended in that month at a meeting of the board, accompanied by Mr. Pincoffs, a London stockbroker, who acted as his interpreter. Philippart was a holder both of original and deferred shares. He had made himself very active in the company's affairs, and upon May 22, 1882, he wrote to the board offering to take up the subscribed capital of the first issue—that is, of the £10 shares—by taking 5,000 shares himself and 5,000 by his friends, on condition that his friends should have the option till June 15 of taking up the remaining 10,000 shares, and that he (M. Philippart) should be elected a director, and that no brokerage should be paid in respect of the allotment of these shares. This was considered at a board meeting on the next day, May 23, and declined. On that day Pincoffs wrote to the company: "I beg to offer to place 7,500 shares of your company at par upon condition of your giving my client the option of taking the remaining 12,382 unapplied-for shares at par until June 23 next, and subject to the usual brokerage of 2s. 6d. per share to myself." The board appear to have taken the advice of their solicitor, who advised them by a letter, which is in evidence, that there was no objection in law to the acceptance of this offer, provided the board were satisfied of the allottee, and that the brokerage was paid by the company, and not deducted from the price of issue. Thereupon the board assented to the proposal, and later in the day a letter was handed to them from Mr. William Morris, a stockbroker, stating that he was willing to take 7,500 shares at par, and pay £2 at once, provided he had the option of taking at par on or before June 23 the balance of the unallotted shares, amounting to about 12,500, and that the board would allow 5s. per share commission on the whole number of shares taken by him, the commission on the 7,500 to be paid at once, the commission on the shares to be paid to Mr. Pincoffs. It is stated in evidence that Morris was known to the directors to be a stock-jobber of very large means. A formal application followed, and on the same May 23 the directors allotted 7,500 £10 shares to Mr. Morris, and paid £937. 10s. to Pincoffs as commission. Subsequently about June 17 they allotted the remaining 12,382 £10 shares to Morris, and paid £1,547. 15s. as commission to Pincoffs. They received from Morris £2 a share on this allotment—that is nearly £40,000. In the meantime the board, on May 24, 1882, had received notice of a charge by Philippart to Leaver on all his shares in the company, and on May 30, 1882, they had notice of an injunction as to the deferred shares of Philippart in the company. They referred this to their solicitor, who wrote on June 17, 1882: "The directors should consider whether, in the circumstances, any transfer of shares to M. Philippart should be registered before being fully paid." On June 30, 1882, M. Philippart was elected a director of the company. On September 27 the company had notice of two charging orders on M. Philippart's shares for £420 and £1,355 respectively. Mr. Morris seems to have been at this time in communication with the board. He had been called on by them to advise, he having a large stake in the company. It appears he was desirous to transfer the shares he held, and on October 11, 1882, the board sanctioned and subsequently passed a transfer of about 19,528 shares from Mr. Morris to M. Philippart. The transfer was completed on October 18. Shortly afterwards the directors against whom this claim is made resigned. A call of £1 per share had been made, and on January 3, 1883, M. Philippart and his brother directors forfeited his shares, which were then about 18,500 in number, for non-payment of that call. Subsequently two other calls of £1 a share were made. On April 10, 1883, M. Philippart became bankrupt. In July, 1884, a winding-up order was made. Thirty shillings had been called up in the liquidation. The debts of the company, it is admitted, have all been paid. Claims to a large amount are outstanding, which the liquidator is resisting, and there are, I am told, some costs of the liquidation still to be provided for.

The claims made by this summons are: first, damages for the alleged misfeasance of the former directors in allotting the 7,500 shares on May 25, 1882, and 12,372 shares on June 17, 1882, to Mr. Morris, a nominee of M. Philippart, or in allowing 18,500 of such shares to be transferred on October 18, 1882, to M. Philippart; and, secondly, that they may be ordered to repay the sum paid to M. Philippart for brokerage on such allotments, with interest. The summons also contains two other claims which have not been opened before me, and which, of course, must be refused. I will deal with these claims in the order in which they are made. It has not been attempted at the bar to urge that the directors are liable in respect of the allotment of Mr. Morris. Mr. Morris was a very substantial person, and I have no reason to doubt that the allotment to him was an advantage to the company. He paid £2 a share, and was liable for the uncalled £8 on all the shares allotted to him. The stress of the argument on the first point related to the transfer to Philippart, as to which the case is put, as I understand, in two ways. It is urged that the defendants did not, in fact, approve Philippart as a transferee under article 28—that is, although they allowed the transfer to him, they did not exercise the judgment and discretion which they were bound to exercise according to that article; and the second contention upon this point is that, if they did, the transaction was so utterly improper that it amounted to a gross breach of duty, for which they may be rendered liable. The first part of this argument rests mainly on a passage in the cross-examination of one of the directors. On page 7 he states that he recollects the attention of the board being drawn on October 11, 1882, to the number of shares which it was proposed that Morris should transfer to Philippart, and he says the matter was well considered, and the directors came to the conclusion the transfer should be passed, as there was no valid objection. This gentleman, who said at page 2 that at this distance of time he found it very difficult to recollect what took place, at page 7 says: "I cannot say whether a discussion of any duration took place on it; no one threw a doubt on the prudence of sanctioning such transfer. We were told by our solicitor at that meeting that, as there was no valid objection, we had no option in the matter. I believe the solicitor was present at that meeting; at all events, it was at a meeting at which the solicitor happened to be present." Another of these gentlemen, at page 34, gives pretty much the same account, and says the solicitor advised them to sanction the transfer, and said they must do so, and could not help themselves.

If it is right to rely on the imperfect recollection of these gentlemen of a discussion which took place five and a half years before, I must say it produces on my mind exactly the contrary effect to that for which they were cited. I should infer *prima facie*, from the mere circumstances of the transfer, that, rightly or wrongly, the directors did approve the transferee, and these statements of the directors confirm that view. They say that the matter was discussed and the advice of the solicitor of the company was taken upon it. But the argument has rather been on the other point, whether such approval was a misfeasance for which the directors are liable. They have made an affidavit, in which they say that when they sanctioned the transfer from Morris to Philippart they did not know or believe that he would be unable to pay the amount uncalled—that is, £8 a share. Looking at the matter in the light of the latter occurrences, the failure of Philippart to pay the calls on the shares, his bankruptcy, and the ruin and winding up under the management, it is easy to see that the transfer was an act much to be regretted; but anything like corrupt or dishonest dealing being out of the question, the difficulty is, can the court—putting itself as completely as is now possible in the position of directors in October, 1882—say that their conduct in then making this transfer was so grossly improper that they can be made liable personally for the consequences. They have been cross-examined at enormous length for eight days, and their depositions, without the questions, cover 35 pages of printed matter. I have read with great care all portions of them which relate to this transaction, and a great deal besides. The case made against them may be shortly summed up thus. On May 23, 1882, the directors had declined to allot to Philippart the 20,000 unallotted £10 shares. They did not particularly like his manner, which was very overbearing. They—or some of them—knew that he had been engaged in large financial operations abroad, and had failed some time previously. It had been brought to their attention that there were judgments against him and charging orders upon other shares which he held in the company, and their solicitors had suggested that they should hesitate to allow any shares to be transferred to him until they were fully paid. Nevertheless, on June 30, 1882, he was elected a director, and on Oct. 11, at a meeting of the board at which he attended part of the time, this transfer was approved. On the other hand, the directors say that they understood that, although he had failed for a very large amount before this company was formed, he was "up again," and that he had made a largish sum of money. The judgments against him had been brought to his attention, and he had said it was all nonsense, and he was not going to be blackmailed. They understood—though not, it would seem, according to present recollection, from any definite information—that he was being backed by some of the most powerful people in France, and had considerable means of his own. They found that the Faure accumulators, the subject of these patents, were very difficult to manage, and that Philippart had an intimate knowledge of their construction, which would be of great use to the company; and principally therefor, and also because of his activity as a shareholder, he was made a director.

I have no doubt that when the question concerning the transfer arose, it seemed to them they had no valid reason for not approving him as a transferee; they knew that he could not obtain a transfer from Morris without satisfying the very large sum of £40,000 which Morris had paid to the company. He did this, to some extent, by transferring other shares to Morris, but he must have provided a large sum in cash. Anything like corruption or dishonesty on the part of the directors being out of the question, I am unable to treat them as responsible for the consequences of permitting this transfer. Even if the act were, with the knowledge they had at the time, a grave error of judgment, there is no ground on which the court could properly hold them liable. Upon the second point I have felt much more difficulty. It was said, in argument against the directors, that the payment of brokerage to Pincoffs is analagous to issuing the shares at a discount. The analogy seems to me imperfect. In the Almada and Tirito Company (Allen's case) 36, Weekly Reporter, the Court of Appeal held that issuing shares at a discount was *ultra vires*, because it would, in effect, be altering the amount of the capital of the company in a manner not authorised by the Joint Stock Companies Acts, and was equivalent to returning part of the capital to the allottee. Payment of brokerage to a person not a shareholder implies a receipt from the shareholder of the full amount payable on the shares, and then in application either of part of the money so received, or other moneys of the company in paying the brokerage. The real question is, whether such an application of capital is within the power of the company. If the payment be completely *ultra vires*, then the directors who made it are as liable for a breach of trust, unless the case comes within the rather exceptional case which I had to consider in Tomkinson *v.* the South-Eastern Railway Company, where the payments were treated as being within the general power of the directors as managers, although not in the strictest sense payment for any of the objects mentioned in the memorandum. In this case there is nothing whatever in the memorandum of association which would justify such a payment, except the words: "To do all such other things as the company may deem incidental or conducive to the attainment of any of the aforesaid objects of the company." The aforesaid objects do not include the issue of the company's shares, but it is argued that the first thing a newly-formed company has to do is to invite and encourage persons to take shares.

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For this purpose, it is said, they may print and issue prospectuses, and they may advertise. Why should they not employ agents to travel about the country and invite persons to join? If they may, such agents must be paid for their services; and what is the difference between that and giving a commission to someone like a broker, who has a large number of clients whom he may induce to take shares in the company? I am not satisfied that such employment of agents would be legitimate; but, if it were, it seems to me that there is a difference, and an important one. Payment of what is called brokerage for placing shares is not real payment for work and labour; it is a commission—that is, a bonus to A to use his influence to make B, C, and D shareholders. Put the simplest case: A says to the directors, "I know a wealthy man whom I can persuade to take 10,000 of your shares. Give me £2,000, and I will induce him to do so." Would that be a legitimate payment? This practice, so far as it exists, has grown up from the launching of bubble companies, which could not be brought out without the aid of speculators who insist on being paid a bonus or commission for their help.

In the case of an enterprise which is favourably received by the public, not a penny need be spent in this way. It is only companies which are unsound, or, at any rate, unpopular, which resort to such devices. In this very case four of the five directors, in their joint affidavit paragraph state that when Mr. Pincoffs' offer was made the company's shares were unsaleable at par, and that accordingly they thought it beneficial to accept his terms. That is a distinct statement that unless speculators were paid out of the shareholders' capital to place the shares, there was no chance of issuing them. In my opinion such a course of proceeding is calculated to lead to a great amount of evil in the commercial world, and ought to be discouraged. These are considerations which must be regarded in determining whether such a payment is *ultra vires*. Another consideration is this. The question does not depend on the amount paid unless it were so large as to suggest *mala fides*. If 2s. 6d. a share may be paid, why not 5s., 10s., or £1? The more needy the company, the greater must be the payment; the more hopeless the enterprise, the larger would be this kind of dealing. The terms of Morris's letter of May 23, 1882, in which he insisted on payment of commission to Pincoffs, suggest a suspicion that this commission would be some pecuniary advantage to him. It is but a suspicion. I have no evidence that such was the case; but I refer to it as an obvious danger that would result from such a practice. Commission to Morris would be issuing shares at a discount. Giving a commission to brokers may, in this way, be a roundabout mode of transferring part of the capital to the allottee.

The capital of the company is placed under the control of the directors for the purpose of carrying on the business of a trading concern. In any expenditure concerning its proper business, the court treats them as having a large discretion. A moderate expenditure in launching the company—that is, in introducing it to the notice of the public to invite them to join—though not part of the trading business, may be treated as conducive thereto. It is not easy to draw a definite line as to every payment of this kind, but the company cannot employ the capital which has been subscribed for the purposes of its business in making payments to induce persons to take shares, to such persons themselves. Can it be legitimate to make such payments to another who has influence over them? Is that such an application of the capital of the company as a general meeting could sanction? Suppose such a meeting called, and the directors were to say, "We have tried all the ordinary means to induce the public to take shares, and failed; by paying a bonus to an influential member of the Stock Exchange, or an influential solicitor or banker, we can get them to persuade their clients to take further capital; sanction our doing this." Could a general meeting validly say that the capital subscribed to carry on the business of a company should be so applied? Without using the word in any offensive sense, the objection to such payments is that they partake of the nature of a bribe. The broker or agent is paid to give advice and use persuasion, which presumably he would not do without such payment. Suppose the broker to say, "Candidly, I think badly of the prospects of your company. I would not take a share in it myself; but pay me and I will find you some foolish people who will do so under my persuasion." Would that be a legitimate thing to do? Yet something of that kind is necessarily involved in every such question. In my opinion the payments to Pincoffs of 2s. 6d. for every share taken by Morris were *ultra vires*—that is, they were an application of the subscribed capital which could not be sanctioned by a general meeting. I have dealt with the question entirely on principle. The actual point does not seem to have arisen before for decision. Two cases have been referred to which have some bearing on it. In the Sydney Company *v.* Bird, Bird and Co., iron merchants, had given a guarantee before the company was formed to Messrs. Allaway, in consideration of a commission of £10,800, by which they promised to guarantee and provide for the subscription raised from the public to complete the capital, and make other payments. The company was registered on December 30, 1881, and, subsequently, on January 9, 1882, the agreement as to guarantee was adopted and modified to this extent, that the guarantee was given by William Bird alone, and £5,000 of the £10,800 were to be paid to him as a consideration for his giving the guarantee, the remainder of the £10,800 being retained by James Bird, his former partner in the firm of which William Bird had ceased to be a member. The action was brought against William Bird and James Bird to recover the £10,800. The Court of Appeal, in 33rd Chancery Division, held that James Bird was liable for the whole £10,800, subject to just allowances, and on the question whether he could be allowed the £500 he had paid to William Bird, the court said: "It appears to us wholly wrong to make the company pay for the issue of its own shares; no part of the capital of the company could be properly so applied. To allow James Bird the £500 paid by him to William Bird would be in effect to make the company misapply its capital." Those words are large enough to include the present case, and, I must observe, they occur in a considered judgment delivered for the court by Lord Justice Lindley, who has paid very great attention to this branch of the law. But I do not rely on them too much, because distinctions may be drawn between the guarantee in that case and the agreement in question in this. I have, therefore, preferred to rest my decision on the reasons I have given. On the other hand, reference is made to Bagnall *v.* Carlton, in 6th Chancery Division, which was a suit against certain promoters of a company seeking to set aside an agreement for the purchase by the company of certain property, and asking repayment of the purchase-money, after deducting such sums as should be declared by the court to be a fair allowance for commission and expenses. The court held that the company, who were plaintiffs, were bound by the offer, made in their pleadings, to allow something to the defendants by way of commission for promoting the company, and Lord Justice James said: "It is clear the defendants are not entitled to commission in any way whatever by reason of the offer which was made in the bill." No question was raised as to such a payment being beyond the powers of the company, and I do not see how there would have been any such questions, because the court was imposing on the plaintiff company certain terms as the price of the relief granted, and the order of the court would have been sufficient, whether the payment was within the company's powers or not. It seems to me impossible to treat this case as a decision of the question.

I must declare that the respondents, the directors, who made these payments are jointly and severally liable to repay the same to the company, with interest at 4 per cent. per annum since the moneys were paid. It has been suggested that the court should follow the example set by Vice-Chancellor Wickens, in Pickering *v.* Stephenson, by declining to order repayment by the directors. In that case, and in Studdart *v.* Grosvenor, in which it was followed, the amount was very small, and the interest of the applicant was almost infinitesimal. Here the amount is considerable, and the liquidator, who applies, represents the whole body of the shareholders, whose liability will be lessened if this money is recovered. The respondents, other than Philippart, against whom no relief is now asked, because he is insolvent, must be ordered, jointly and severally, to make the payments I have mentioned I must refuse the summonses, with costs, as to all the claims, except the second, which I allow with costs, such costs to be set off.

COMPANIES' MEETINGS.

AUSTRALASIAN ELECTRIC LIGHT, POWER, AND STORAGE COMPANY.

The sixth ordinary general meeting of the Australasian Electric Light, Power, and Storage Company, Limited, was held on Monday last at the offices, Coleman-street, E.C.

Mr. B. H. Van Tromp presided, and, in moving the adoption of the report, observed that there had been a loss on the year's working to the 31st of December last. Arrangements had now been made with the view of reducing the expenses in London and Australia, and he ventured to hope that at their general meeting next year they would be able to place such a statement of accounts and such a statement of the progress of the Company before the shareholders that the latter would continue their confidence in the Board Their efforts had been mainly directed in the past year to securing the contract for lighting the Melbourne Exhibition, and, in spite of the great competition, they obtained the contract. As far as their present advices enabled them to say, they would receive a net profit of £4,000 or £5,000 from it. In addition to that profit, the lighting of the exhibition had given a great start to the electric light industry. The commissioners to the exhibition had stated that the entire work had been carried out to their satisfaction. Instead of making a call in order to meet the expenditure which the contract involved, the Directors gave their personal guarantee and entered into a very satisfactory arrangement with the Anglo-American Brush Company to supply the plant. They were now paying that company off rapidly, as the money for the work was received from Australia. All that the Company wanted was some more capital; and he firmly believed that if they could obtain £15,000 or £20,000 by an issue of preference shares, which they could devote to the establishment of a lighting station in some large city, like Bombay or Calcutta, a handsome return could be made on the investment. He believed they had a great future in the Australian Electric Company, which was established in Melbourne, and in which they held one-third of the capital. There was no reason why everyone in London should not be supplied with the electric light in time, and he ventured to predict that there would be no increase in its cost over gas or candles.

Mr. Gueedon (a shareholder) seconded the motion.

After a short discussion, in which **Mr. Morrison, Mr. B. Kisch, Colonel Wilkinson, Sir Henry Hoare, Mr. Ince,** and **Mr. Verity** took part, the report was unanimously adopted, and the retiring Directors and Auditors were afterwards re-elected.

The question of an issue of preference shares was left to the consideration of the Directors.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.

The twenty-third ordinary general meeting of the West India and Panama Telegraph Company, Limited, was held on Wednesday last at Winchester House, Old Broad-street, Mr. C. W. Earle presiding.

The **Chairman,** in moving the adoption of the report and the payment of 12s. per share on account of arrears of dividend on the first preference shares, stated that that was the first time they had met in the 20 years' existence of the Company having everyone of their cables in working order. He did not, however, wish them to

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draw too favourable an augury from that fact, though he believed that their system was in a stronger and better condition than it had ever before been in. Since the report was written they had had one interruption; but it had been very quickly repaired by their maintenance ship, the "Duchess of Marlborough." They had had a small increase in their traffic revenue, and the chief increase on the other side of the account had been owing to the expense of repairs to the cables, which had cost £2,241 in excess of the expenditure in the corresponding period of the previous year. That increase was entirely accounted for by the extra length of cable they had been obliged to put in; but that expenditure diminished the amount which they would otherwise have to place to the credit of the reserve fund, which in the case of a telegraph company was principally a depreciation fund for renewing the cable from time to time. The policy of forming the reserve fund had frequently been criticised at their meetings; but the Directors had never ceased to maintain it, and he hoped they would be encouraged to do so in the future by the great body of the shareholders. He regretted that there was a growing feeling among the various Governments in the region served by the Company's system against the long continuance of subsidies. At first they were voted for 10 years, but now they were voted annually. That was an unfortunate policy both for the Company and the places they served. Another cause for anxiety in regard to their position in the West Indies was the renewal of the French competition. Since their last meeting the French company had laid a cable from Venezuela to San Domingo and Santiago de Cuba. At present the French company interfered very little with their traffic, but one of the objects of that Company was to promote and develop French telegraphs. They were not without some anticipation that the French company might eventually make extensions into the Company's territory, and not one of their stations could support another company. They had called the attention of the Spanish Government to the contraventions of the Company's concession by the French company.

Mr. William Ford seconded the motion.

In reply to questions, the **Chairman** stated that the total amount of subsidies receivable by the Company was £24,000 a year; but deductions were made for interruptions and various other things. The reserve fund was carefully calculated to meet the depreciation which was constantly going on in their cables; and they could not, in duty to the Company, appropriate any portion of it to paying off the arrears of dividends.

The motion was then unanimously adopted.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the past week amounted to £5,782.

West Coast of America Telegraph Company.—The receipts for the month of August amounted to £6,600.

Crompton and Co.—Letters of allotment to applicants for shares in Crompton and Co., Limited, have been posted.

Humboldt Electric Power and Mining Company, Limited.—The letters of allotment of shares in the Humboldt Electric Power and Mining Company, Limited, have been posted.

Notice of Removal.—Messrs. Gent and Co., manufacturing electricians, electric light engineers, etc., have removed fron Faraday Works, King Richard's-road, to Braunstone Gate, Leicester.

Western and Brazilian Company.—The receipts for the past week of the Western and Brazilian Company, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Company, were £4,728.

Companies of the Month.—The following electrical companies were registered during the past month:

Automatic Electric Supply Company, £1 shares	£25,000
Carlton Engineering Company, £1 shares	10,000
South African Lighting Association, £10 shares	50,000
Ward Electrical Car Company, £10 shares	300,000

NEW COMPANIES REGISTERED.

The Ward Electrical Car Company has been registered with a capital of £300,000 in £10 shares, to carry on business as electrical and mechanical engineers, carriage-builders, railway, tramway, and road proprietors.

Metallurgical Patents Company.—Registered with a capital of £20,150, in 2,000 ordinary shares of £10 each, 100 founders' shares of £1 each, and 50 B shares of £1 each. The objects of the Company are to acquire any secret or other information as to any invention or inventions whatever, and, with a view to turning the same to account, to carry on any business as may seem expedient.

Manlove, Alliott and Company, Limited.—Registered by Richard Jordan, 120, Chancery-lane, W.C., with a capital of £100,000, in shares of £10 each. Object: to purchase or acquire the business of mechanical and colonial engineers, machine and engineering tool makers, boiler makers, iron and brass founders, millwrights, coppersmiths and manufacturers of machinery, and general merchants, carried on by Edward Manlove and James Bingham Alliott, under the style of Manlove, Alliott, Fryer and Co., at Bloomsgrove Works, Nottingham, and elsewhere, and the lands, factories and workshops, sheds, buildings, engines, boilers, machinery, tool, plant, material, stock-in-trade, patents, book debts and assets of the said business, and the goodwill and interest of the said Edward Manlove and James Alliott therein; to continue the business and to carry on the business of electricians, suppliers of electricity for the purposes of light, heat, motive power, or otherwise, and of manufacturers of and dealers in all apparatus and things required for or capable of being used in connection with the generation, distribution, supply, accumulation and employment of electricity. The first subscribers are:

	Shares.
E. Manlove, Devonshire House, Buxton	1
J. B. Alliott, The Park, Nottingham	1
J. M C. Paton, Parkside, Nottingham	1
E. A. Manlove, 20, Queen Victoria-street, London, E.C.	1
T. Cantrell, 55, Burford-road, Nottingham	1
W. B. Thorpe, maltster, Nottingham	1
J. Hind, solicitor, Nottingham	1

The Lancashire and Engineering Company, Limited.—Registered by Waterlow Brothers and Layton, Birchin-lane, E.C., with a capital of £20,000, in shares of £5 each. Object: to carry out at Bolton and elsewhere the businesses of mechanical, hydraulic and general engineers and machine makers, electricians, electrical engineers, and workers and dealers in electric and other motive power and light. The first subscribers are:

	Shares.
M. Settle, Snow-hill, Darcy Lever	1
J. Atherton, Bolton	1
J. West, Houghton	1
G. H. Pearce, Tyldesley	1
G. Crowther, Bolton	1
J. C. Sewell, Bolton	1
F. W. Briscoe, Bolton	1

There shall not be less than five nor more than seven Directors of the Company, and the first shall be Miles Settle, James Atherton, James Tonge, Geo. H. Pearce, and George Crowther.

PROVISIONAL PATENTS, 1888.

NOVEMBER 2.

15,801. **An improved joint for electric light fittings.** Alexander Bewicke Blackburn, 13, Albert-mansions, Victoria-street, S.W.

15,865. **Improvements in multiple printing telegraph apparatus.** Claude Joseph Munier, 6, Bream's-buildings, London, E.C. (Complete specification.)

15,868. **A process of reduction of aluminium by electrolysis.** August Winkler, August Kuhnt, and Robert Deissler, 38, Alexanderstrasse, Berlin, Germany.

15,869. **Improvements in electro-magnetic induction apparatus.** Cornelius Bennett Harness, 45, Southampton-buildings, London.

NOVEMBER 3.

15,877. **Pocket or portable secondary batteries or accumulators.** Emile Rousseau, 3, Leopold-terrace, Knott's Green, Leyton, Essex.

15,910. **Improvements in galvanic batteries.** Louis Kayser, 23, Southampton-buildings, Middlesex. [Date applied for under Section 103 of the Patents, &c., Act, 1883, 13th April, 1888.]

15,915. **Improvements in electric arc lamps.** Frederik Vilhelm Andersen, 3, Elm-court, Temple, E.C.

15,921. **An improvement in electric railway signals.** Alexander Siemens, 28, Southampton-buildings, Chancery-lane, London W.C.

15,928. **Improvements in electrical motive power engines.** Eugene Duvalle and Alphonse Dousson, 35, Southampton buildings, Chancery-lane, London.

NOVEMBER 5.

15,947. **Improvements in systems of electric traction for railways and tramways.** Charles Barnard Burdon, 130, Dale-street, Liverpool.

15,949. **Improved methods of applying electricity to a general system of traction.** Thomas Pease and Charles Barnard Burdon, 130, Dale-street, Liverpool.

15,961. **An improved electrical fabric for medical purposes.** Thomas Field, jun., 110, Pethertou-road, Canonbury, N.

15,985. **Improvements in or connected with mariners' compasses.** George William Atkins, 166, Fleet-street, London.

15,989. **Improvements in dynamo-electric machines and electro-motors.** Benoit Joseph Xavier Gosselin, 4, South-street, Finsbury, London.

NOVEMBER 6.

16,047. **Improvements in magneto-electric railway signals.** Wm. Phillips Thompson, 6, Lord-street, Liverpool. (The Pennsylvania Steel Company, United States.)

16,048. **Improvements in or relating to secondary or storage batteries.** William Phillips Thompson 6, Lord-street, Liverpool. (Charles Henry Thompson, United States.)

NOVEMBER 7.

16,140. **Improvements in the charging of secondary electric batteries from primary batteries, and apparatus for that purpose.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London, W.C.

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16,129. **An improvement in the contact makers of electrical alarms for doors and windows.** Joseph Emile Lansard, 53, Chancery-lane, London.

16,141. **Electrical contact apparatus worked by passage of a railway train.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London, W.C.

16,146. **Improvements relating to electro-medical batteries.** Francis Moreton, Gray's-inn-chambers, 20, High Holborn, London, W.C. (Complete specification.)

NOVEMBER 8.

16,202. **Improvements in and connected with electrical billiard-marking apparatus.** James Joseph Hine, 54, Fleet-street, London, E.C.

COMPLETE SPECIFICATIONS ACCEPTED.

NOVEMBER 8, 1887.

15,217. **Improvements in measuring alternating currents of electricity.** William Lowrie, Charles James Hall, and Harold Werner Kolle, 433, Strand, London, W.C.

NOVEMBER 29, 1887.

16,398. **Automatic machines for the supply of liquids on draught by electrical and other means.** Benjamin Wm. Warwick, 134, Highbury-hill, London, N.

DECEMBER 6, 1887.

16,790. **Improvements in dynamo-electric machines.** Sophus Christopher Hanberg, 18, Buckingham-street, Strand, London.

16,807. **Improvements in or connected with incandescent electric lamps.** David Urquhart, 47, Lincoln's-inn-fields, London.

DECEMBER 21, 1887.

17,582. **Apparatus for indicating the time during which electricity is used for lighting or other purposes.** Edward Frederick Hermann Heinrich Lauckert, 28, Southampton-buildings, Chancery-lane, London, W.C.

DECEMBER 22, 1887.

17,641. **Improvements in printing telegraphs.** John Edward Wright and John Moore, 24, Southampton-buildings, London, W.C.

DECEMBER 27, 1887.

17,807. **Improvements in the construction of rheostats or similar electrical instruments.** Frederick Lawrence Rawson, of and on behalf of The Woodhouse and Rawson Electric Manufacturing Company, Limited, 1, Queen Victoria-street, London, E.C. (Charles Wirt, New York.)

JANUARY 5, 1888.

208. **Improvements in the utilisation of waste products from electrical batteries.** Owen Charles Dalhousie Ross, 8, Quality-court, London, W.C.

JANUARY 7, 1888.

295. **A new or improved electric meter.** Thomas Parker, of the firm of Elwell-Parker, Limited, and Edmund Rees, 70, Market-street, Manchester.

302. **A new or improved electric meter.** Thomas Parker, of the firm of Elwell-Parker, Limited, 70, Market-street, Manchester.

JANUARY 17, 1888.

705. **A mouthpiece to be attached to the transmitter of the telephone.** Leo Eugéne Percy, 9, London-street, Southwark, London, S.E.

JANUARY 23, 1888.

1016. **An improvement in electrical transforming apparatus.** Alfred Mills Taylor, 28, Southampton-buildings, Chancery-lane, London, W.C.

JANUARY 24, 1888.

1,105. **Improvements in the means or appliances for treating sewage by electrolytic action and for disposing of the deposits thereof.** William Webster, jun., 28, Southampton-buildings, Chancery-lane, London, W.C.

FEBRUARY 14, 1888.

2,259. **Improvements in thermo-electric and furnace batteries.** Hugo Mestern, 142, Fleet-street, E.C.

JULY 18, 1888.

10,415. **Improvements in the manufacture of electrical dry elements.** Carl Gassner, jun., 33, Southampton-buildings, Holborn, London.

AUGUST 21, 1888.

12,066. **Improvements in or relating to electrical type-writers capable of being used as printing telegraphs.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.)

SEPTEMBER 10, 1888.

13,035. **Improvements in the construction of socket electric lampholders, wall-sockets, and electric lead connecters.** Charles Mark Dorman and Reginald Arthur Smith, 24, Brasenose-street, Manchester.

SEPTEMBER 11, 1888.

13,122. **Improvements in the armatures of dynamo electric machines.** Edward James Paterson and Charles Friend Cooper, European Works, Pownall-road, Dalston, E.

OCTOBER 9, 1888.

14,522. **Improvements in galvanic batteries.** David Humphreys, 226, High Holborn, London.

SPECIFICATIONS PUBLISHED.

1882.

3576. **Distributing, &c., electricity.** J. Hopkinson. (Second edition.) 8d.

1887.

14,632. **Electrically lighting railway trains.** I. A. Timmis. 8d.

15,161. **Coin-freed electrical current-producing apparatus.** P. Everitt. 8d.

15,735 **Electrical indicating apparatus.** W. R. Lake. (Grivolas.) 8d.

16,324. **Electro-mechanical striking gongs.** F. T. Schmidt. 8d.

16,370. **Electro-dynamic generators, &c.** R. Tatham. 8d.

17,409. **Electrical primers.** C. A. McEvoy. 6d.

1888.

729. **Electric batteries.** D. Urquhart. 6d.

12,396. **Electric motors for self-winding clocks.** W. P. Thompson. (Edgecomb.) 8d.

12,437. **Electrical conductors.** W. A. Conner and J. W. Marsh. 8d.

13,128. **Electric railway signalling systems.** J. Irwin. 8d.

13,193. **Bleaching paper pulp by electrolysis.** E. M. H. Andreoli. 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	99½
12 Feb.	1/2	Anglo-American Brush E.L.	4	4¼
12 Feb.	2/0	— fully paid	5	5¼
26 Oct.	7/6	Anglo-American	100	46½
26 Oct.	15/0	— Pref.	100	78
12 Feb., 85...	5/0	— Def.	100	17½
28 June	3/0	Brazilian Submarine.....	10	13½
14 June	1/0	Con Telephone & Main ...	1	⅛
10 Aug.	9/0	Cuba	10	14
10 Aug.	10/0	— 10% Pref.	10	18½
12 Oct.	2/0	Direct Spanish	5	4
12 Oct.	5/0	— 10% Pref.	5	10½
26 Oct.	2/0	Direct United States	20	9¾
12 Oct.	2/6	Eastern	10	12⅜
12 Oct.	3/0	— 6% Pref.	10	14⅞
1 Aug.	5%	— 5%, 1899	100	110
26 Oct.	4%	— 4% Deb. Stock	100	106¼
12 Oct.	2/6	Eastern Extension, Australasia & China.....	10	13¼
1 Aug.	6%	— 6% Deb., 1891	100	104½
2 July	5%	— 5% Deb., 1900	100	104
2 Nov.	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	105
28 Mar.	8/3	German Union	10	9
13 Oct.	1/0	Globe Telegraph Trust.....	10	7⅛
12 Oct.	3/0	-- 6% Pref.	10	14⅛
30 April	5/0	Great Northern.....	10	14½
1 March.....	5%	Gt. Northern 5% Deb., '83.	100	103½
27 July	10/0	India Rubber, G. P. & Tel.	10	17
26 Oct.	12/6	Indo-European	25	39½
30 May	3/0	London Platino-Brazilian...	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
.....	...	Swan United	3½	2⅜
10 Aug.	13½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust ...	100	97
12 July	12/0	Telegraph Construction ...	12	38⅞
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	13⅞
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	98
12 July	4/0	West Coast of America ...	10	8
30 June	8%	— 8% Debs.	100	115
26 Oct.	6/0	Western and Brazilian.....	15	14⅛
26 Oct.	6/	— Preferred	7½	7⅛
11 May	2/1½	— Deferred.....	7½	7¼
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
.....	...	West India and Panama ...	10	2⅛
30 May	10/0	— 6% 1st Pref.	10	12½
13 May, '80...	...	— 6% 2nd Pref.	10	12
2 Nov.	7%	West Union of U.S.....	$1,000	122
1 Mar.	6%	— 6% Sterling	100	104

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NOTES.

Electric Waggons.—Kansas City is shortly to have an electric accumulator waggon running in the streets.

Leeds.—At the meeting of the Leeds Town Council last Friday the Electric Lighting Committee were re-appointed.

To What Base Uses.—The papers of this week give the case of a father at Plaistow who was brought up before the magistrates for beating his son with a piece of old telegraph cable.

Board of Trade Returns.—The Board of Trade returns for the month of October show a falling off in telegraph wire and instruments from £31,475 in 1887 to £17,038 in 1888.

Ocean Signalling.—The invention is announced by Daniel Drawbaugh of an apparatus for signalling to vessels in mid-ocean, which it is thought will create a revolution in naval affairs. A public exhibition is to be made shortly.

Blockley.—The village of Blockley, Worcester, has been lighted by a large electric light on a mast above the tower. Incandescent lights are also used for the further ends of the streets, and for the church and some of the principal shops.

Leamington.—The replacing of the smaller incandescent lamps with others of higher candle-power and with small arcs has been commenced, and a number of these lamps running for the past week or two. The new lights are more brilliant than the old, and till these latter have been entirely removed, unfavourable comparisons are made.

Telegraph Engineers' Students' Meeting.—A students' meeting was held on Thursday, November 15, Prof. J. A. Fleming, M.A., D.Sc., in the chair. Mr. C. G. Lamb, B.Sc., read a paper, entitled "A Resumé of the Question of Electrical Oscillations." Prof. Fleming made some remarks on the same subject, and a short discussion followed, in which Messrs. E. W. Smith, Sheppard, and Rance took part.

Wood Casings.—The constant increase in private and public use of electric light is waking up the timber merchants to the trade to be done in wood casings. We have received a frame of sample casings from Messrs. J. F. and G. Harris, mahogany and timber merchants and moulding manufacturers, 58, Wilson-street, Finsbury, E.C., together with a large sheet of very nicely printed drawings, showing the same in full sizes.

Pilot Dynamos.—An idea, which might be more largely imitated in mill lighting, has been carried out in the mills of Messrs. Merrall and Son, spinners, Haworth. The dynamos are supplied by Luther, Hanson, and Co., of Halifax, and, besides the necessary switches and cut-outs and fittings for the main circuits, there is a small pilot 3½ unit dynamo, run off a water-wheel, and intended to supply three 32 c.p. lamps in each room of the mill when the machinery is stopped.

Telegraph Poles.—The accepted tenders for the supply of telegraph poles and creosoting same, for the Postmaster-General, London, are as follows: Supplying telegraph poles in London, Messrs. Rasmusen and Franklin, Porsgrund, Norway; creosoting same, Messrs. Burt, Boulton and Haywood, 64, Cannon-street, London, E.C. Supply-telegraph poles in the Tyne, Messrs. R. Wade, Sons and Co., of Hull; creosoting same, Messrs. Armstrong, Addison and Co., Sunderland.

Telegraph Stores.—The North-Eastern Railway Company require tenders for the supply of the following articles, in such quantities as they may require, during six months ending June 30, 1889, delivered carriage paid at the company's telegraph stores at York: (1) Telegraph apparatus; (2) telegraph wire and line stores. Forms of tender may be obtained on application to Mr. Grave, Telegraph Department, York, and tenders must be sent to the Secretary at York, sealed and marked "Tender for Telegraph Stores," by noon on 27th inst.

Overhead Wires.—In the House of Commons on the 15th inst., in reply to a question upon electric overhead wires by Mr. Bradlaugh, Sir M. Hicks-Beach said that no overhead wires for the purpose of electric lighting had been sanctioned so far. He could not make any definite promise with regard to future applications on the subject with reference to the metropolis; but certainly he should not be disposed to sanction such applications. Mr. Brunner asked whether the right hon. gentleman had power to prohibit the erection of such wires in the metropolis. Sir M. Hicks-Beach said that was a question he would rather not answer at present.

South Africa.—A company, under the title of the South African Lighting Company, has been registered, to supply gas, electric, or other light in South Africa. A number of gentlemen connected with the gas industry have joined; but we should imagine that even these gentlemen will see that the interests of shareholders in the money-making part of the business would be best secured by starting on the electrical plan, rather than putting up gas works, and then converting them to electric works. This is what many companies have found it necessary to do in America and on the Continent. There is a good chance to start right in a new undertaking.

The Telegraph Cheaper than the Post.—The fast-speed telegraph apparatus of Mr. Craik, Washington, is claimed by the inventor to make it cheaper to telegraph letters than to post them. The system reduces the English alphabet to ten elementary characters. The messages are prepared by means of a machine resembling a typewriter, and manipulated in the same manner. With the use of ten keys, one for each character, any message can be written. At a recent test a message of seventy-six words is reported as having been sent over the wires in twenty-five seconds, and printed on a tape in plain Roman characters. The inventor claims that by this system one wire can do the work which now requires ten.

West Coast of Africa.—We mentioned recently that soundings had been made for a proposed continuation of cables along the West Coast of Africa to the Cape. We now hear that the Silvertown Company has commenced to make the cables for this extension, and that the cable ships are expected to start early in the new year for the scene of operations. Yesterday the Eastern Telegraph Company held an extraordinary general meeting to obtain the sanction of the shareholders to an issue of 20,000 new shares of £10 each, this new capital being required to subscribe and pay for a like number of shares in the Eastern and South African Telegraph Company. The completion of this work means that Africa is surrounded by cables both on the east and west coast.

Kensington.—The question of the lighting of the parish of Kensington by electricity came up at the meeting

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of the Kensington Vestry last week. Mr. Lindsay objected to mapping out the parish, as was proposed, to four companies; and said that, though the committee pretended not to want to grant a monopoly, this would be virtually created by the adoption of their proposal. He therefore moved that the vestry should give authority to the whole seven electric light companies who had applied for permission to supply light, without alloting any particular part of the area. The proposal was carried by 38 votes to 19. The chairman of the committee, Mr. Jordan, and two members resigned their positions in consequence of this decision. Ultimately, the vestry reconsidered their decision, and postponed the matter for a fortnight.

"New Patent" Electric Light.—We notice a report that the Allendale Improvement Committee have a proposal submitted to them, with estimates of cost of apparatus, for lighting their town with Milburn's "new patent electric light." As new patents for electric light are not worth very much just now, seeing that nearly all that can be has been patented long ago (except variations in primary batteries—there seems hardly end to those) we should be glad to hear in what the great newness consists, and should advise the committee of Allendale to be rather careful of new patent electric lights—batteries or otherwise, unless properly advised by an experienced electrical engineer. If Mr. R. P. Milburn, of Newcastle, will send on the particulars, we perhaps might be able to express an opinion of the advantage of lighting Allendale with the new patent light.

Heat Researches.—The Society of German Engineers offer a prize of £250, open to the whole world, for the best paper on the following subject: Critically to collate all the existing experimental researches on the passage of heat through heating surfaces, with regard to the material, form, and position of these, as well as to the kind, the temperature, and the movement relations of the bodies taking up and giving out heat; and, on the basis of this collation, bring out the gaps in existing knowledge; and, further, through experimental work in any chosen direction, do something towards filling up these gaps. Papers must be sent to the secretary of the Verein Deutscher Ingenieure, Berlin, by December 31, 1890. The committee consists of Prof. Dr. Bunte (Carlsruhe), Director Gyssling (Munich), Prof. Schröter (Munich), Oberingenieur Einbeck (Stuttgart), and Oberingenieur Hausbrand (Berlin).

Paddington.—The Paddington Vestry, it is said, have resolved to obtain plans and specifications to enable them to proceed with an application to Parliament for a license to supply the electric light for public and private purposes throughout the parish. We believe that the vestry is in communication with a consulting engineer on this question. According to the report of the *Metropolitan*, the Electric Lighting Committee recommended that they should be authorised to engage the services of Mr. George Forbes, F.R.S., to advise them generally as to the supply of this light, and engage him at the cost of 100 guineas. Mr. Chas. Lee objected to the engagement of the gentleman named. After some further discussion, Mr. Overseer Jackson moved, as an amendment, that the services of Dr. Hopkinson to advise as above be engaged at the cost of 50 guineas. Mr. Wills seconded, and the amendment was put and lost, and the recommendation of the committee carried.

Smoking Concerts.—The air is thick with electrical smoking concerts just now. The Old Students' Association held a very successful smoking concert last week at Anderton's Hotel, at which a large number of old and present students turned up, with a fair sprinkling of professors in genial mood. Last Monday Messrs. B. Verity and Son held a smoking concert at the Horse Shoe Hotel in connection with their employés' athletic club. There was a remarkably good attendance. Some very fine songs, musical pieces, and recitations were given, and a thoroughly enjoyable evening was experienced, under the presidency of Mr. John Verity. The E. P. S. Cricket Club will hold a smoking concert at the Eastern Hotel, Limehouse, next Monday; chair to be taken at 7.45 p.m. by Sir Daniel Cooper, Bart. The next concert of the Electro-Harmonics, to be held on Friday, November 30, will be a ladies' night, and a programme of the evening will be found in another column.

"Lighting London."—The modesty of Yankees is proverbial in statements of their own prowess. There is something large and generous about the way in which the Westinghouse Company announce the award of their contract, in the New York papers, of a plant which, if it is carried out, will only be one out of half a score or so of similar central stations in London. The announcement states that the company "has been awarded the contract for a plant to light the City of London, England. It will be the largest plant in the world." The present order, adds the New York *Electrical Engineer*, from whom we extract the above modest press-telegram, is "for a 25,000-lamp outfit," and congratulates itself that American enterprise has met and vanquished persistent home competition in supplying a plant of this magnitude. Our esteemed contemporary will no doubt hereafter appreciate that both "competition," and "this magnitude" are very good—under the circumstances.

Milan.—A gentleman recently returned from Italy states that the electric lighting of the city of Milan is one of the most remarkable signs of the advancement of modern times. As we have stated in our remarks upon Italy, the principal streets are illuminated by Thomson-Houston arc lamps, suspended high up above the centre of the roadway, the result being that both foot-passengers and vehicles receive their fair share of the brilliant light. But the most perfect and startling effect is in the Piazzo De Dol Duomo, which is the large open space in front of the cathedral. Here the Thomson-Houston lamps are on exceedingly handsome and artistic iron standards. The exquisite carvings on the old cathedral can be seen in bold relief, and the effect of the soft light of the electric lamps, which burn without a flicker, show up the white marble of this magnificent place of architecture in a marvellous manner, and it may now truly be said that Milan Cathedral by night is probably one of the most impressive ecclesiastical sights in the world.

Killed by an Electric Shock.—The *Corriere della Sera*, of Milan, dated 12th November, reports a fatal accident to a workman named Bertola, who was employed by the Edison Company at their central station in Milan. Bertola was in charge of an installation at the Theatre Dal Verme, in Milan. The theatre is some distance from the station, and Zipernowski transformers are employed in the installation. The deceased entered the room containing the controlling apparatus, and was at once seen to fall. Attendance was at hand, and a doctor was immediately summoned; but instantaneous death had resulted from a shock received on his accidentally touching, as is supposed, an insulated portion of

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the circuit. This accident points to the necessity for the most strict precautions wherever high-tension currents are used, and for covering all bare terminals connected with such circuits, so that it is impossible to touch them accidentally. English firms are not free from fault in the matter of protection of high-pressure terminals, and this point ought to receive special attention from every engineer in charge of high-tension plant.

The Underground Railway.—We are glad to hear that satisfactory progress is being made towards the construction of the electric locomotive for the Metropolitan Railway. Many misleading statements having appeared, it may be as well to state briefly what, as we understand, is really proposed by the Electric Traction Company, who have the matter in hand. The Metropolitan directors stipulate that the "Electromotive" shall do their work as efficiently and under precisely similar conditions as the steam locomotives, and without any disturbance of the line or the traffic. This precludes the use of the direct current in any experiment, and necessitates the employment of an independent locomotive with tender, carrying its own power in accumulators simply for the purpose of proving that sufficient power can be exerted by the electromotive. It is only intended to be an experimental demonstration, the electromotive being specially constructed to be used eventually with the direct current. For obvious reasons, it has never been contemplated to use accumulators in any permanent system of practical working. The motors on the engine are being constructed by Messrs. Immisch and Co.

Robey's Compound Engine.—The *Lincoln Gazette*, noticing the compound horizontal engine sent to the Glasgow Exhibition for driving the Brush dynamo, says: "Visitors to the Glasgow Exhibition will have noticed the very fine display of engines in the Electric Light Department. Prominent among these, and distinguished by the simplicity of its construction, and the remarkable smoothness of the running, was an engine of about 300 h.p., by Robey and Co., of Lincoln, the only engine from Lincoln in the exhibition, and a very fine example of first-class work. Few people who have not seen it would have believed that such high-class machinery, and of so large a size, could have been produced in Lincoln shops, which up to a few years ago were associated only with agricultural machinery. We are glad to learn that the engine in question is to remain in Glasgow, having been purchased by one of the celebrated firms of that city (Messrs. J. and G. Thompson, engineers and shipbuilders, Clydebank, Glasgow) for their own use. Considering the number of engine-builders there are in Glasgow, many of whom had engines in the exhibition, it is a high compliment to Lincoln and to Messrs. Robey's productions that their engine should have been purchased by so eminent a firm of Glasgow engineers."

Rothesay.—A letter from a Scotchman, long resident in America, but temporarily resident at Rothesay, suggests the lighting of the town by electricity. He thinks it might get on much faster and better if it had more of the "go-aheadism" of the Americans; and he suggests that the beauty of the lovely crescent bay (a miniature Bay of Naples) and its sloping hillsides would be much increased if they were lighted with the brilliant electric light instead of a dingy gas. Not only, he remarks, is every first and second rate town in the States illuminated in this way, but many twentieth and thirtieth rate towns are so lighted. Great Falls (which is the nearest town to his own sheep farm in Montana) is, he says, a place of only 1,500 inhabitants, and yet it has been lighted by electricity for years. The local paper follows up the suggestion, concluding an article on the subject thus: "Now that the embargo foolishly placed by Parliament on the adoption of the electric light is about to be removed, all enterprising towns will, no doubt, be setting about its adoption. There is in Rothesay a water-power wasting into the sea from Loch Fad more than sufficient to develop electricity enough to light all the dwellings and streets of the town; and it would be a feather in our cap if we should manage to be the first town in Scotland to adopt this great improvement in lighting."

American Gas Light Association.—The president of this association, in his inaugural address last month, made the following statement: "The increase in the consumption of gas had ranged from 5 to 30 per cent. Considering the cause of this, he thought the natural tendency with all consumers was towards the use of more light. The low price allowed a more free and extended use of gas; and the consumption for cooking and heating purposes was constantly increasing. The application and use of the electric light had almost compelled people to have more light of all kinds; and though the market price of gas stocks had at times suffered from the progress of this new system, the gas business as a whole had rather progressed. He regarded the idea of 'fighting' the electric light as a mistaken policy; and urged that they should rather lend their energies to the development of the possibilities in their own business, which were greater than most people were aware of. All things considered, gas must still remain, as it had been in the past, as best adapted for universal illumination and heating. He was not entirely in favour of the policy of amalgamating the business of electric lighting with that of gas lighting, and did not think that any man could manage two different kinds of business as he could one. One or other must in some degree be neglected, and perhaps both. At the same time he acknowledged that in some cases local circumstances and conditions might render it advantageous to consolidate the two interests, and wise managers would be governed by these circumstances rather than by any general rule."

Tenders for Swansea.—At the adjourned meeting of the Swansea Town Counail, held on Wednesday, Mr. Martin moved the adoption of the minutes of the special committee *re* gas, which stated that the surveyor had reported the result of his visits to various places where public and private lighting is effected by electricity, and in accordance with his suggestions it is recommended that tenders be invited for the lighting of an area including the following streets: Somerset-place, Mount-street, Wind-street, Castle-square, Castle-street, High-street (to Prince of Wales-road), Alexandra-road, Grove-place, De-la-Beche-street, Cradock-street, Union-street, Northampton-place, Dillwyn-street, Oxford-street, Goat-street, Temple-street, and Caer-street, and, to a certain extent, the streets leading therefrom. The present cost of lighting this area is £539. 13s. 8d. per annum, and the surveyor estimates that to light the same with electricity will cost an additional £175 per annum, or 30 per cent. more, while the total increase in illuminating power will be raised from 3·288 to 44·400 candles. The surveyor was directed to supply each member of the committee with a plan showing the proposed position of the electric lamps in the area referred to. It was decided, on the suggestion of Mr. Martin, to invite tenders for lighting the streets named by electricity. The

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cost, he said, would be £275 greater, but the illuminating power would be 44,400 candles, as against 3·288. On that ground alone he had no doubt the town would be glad to have the alteration. Mr. Richards seconded the motion, which was agreed to.

Southern Association of Gas Managers.—At the recent meeting of the Southern Association of Gas Managers, in the discussion on "Some Hindrances to the Sale of Gas," Mr. C. C. Carpenter said: "He was afraid there was a tendency to run after the small consumers, and let the large ones go after the electric light. Electric light was, no doubt, making headway, and he thought that the subject should be dealt with. For himself he believed that everything could be done with gas that the electric light was capable of effecting. He was one of the few gas people who lived within the range of electric lighting. They were on one of the oldest circuits in London; and they were continually having breakdowns. With the electric light, unless they had some artificial means of ventilation, the atmosphere was not so fresh as with gas light. They heard people say that ferns and flowers were unable to live in rooms lighted by means of gas; but his ferns "turned up their toes" in a week in a room where the electric light was used. By putting in one of Sugg's ventilating burners, however, the difficulty was overcome. The other occupants of the house where he resided were quite ignorant as to what gas could do, their notion of it being based upon that relic of barbaric gas times—the union-jet burner—whereas gas lighting could be made as artistic and decorative as electricity itself at less than one-third its cost. He thought the proper education of the consumer was a very important subject, and one that would have eventually to be taken up. He noticed nearly every night when going home that some shop or hotel or lodging-house had the electric light where it was not on the night before." This seems to be a very effective advertisement for the electric light interests, and we think when Mr. Carpenter's views are followed, and the education is daily carried on, the result will be not so very much in favour of gas, but preferably towards electricity.

Cost of Electric Lighting.—We have received a pamphlet on the comparative cost of gas and electric light from Messrs. Carey and Fricker, 12, Delahay-street, S.W. The annual cost of 100 lamps burning 5ft. per hour for 1,500 hours at 3s. per 1,000, is given as £112. 10s., to which waste and renewals (10 per cent.), and proportion of man's wages for cleaning (3s. per week, £7. 16s.), are added, making an annual expenditure of £131. 11s. For electric light, burning 1,500 hours, the cost is given as £119. 10s., being as follows: Renewals of lamps, 100 at 5s., £25; interest on £350, £17. 10s.; depreciation on engine and dynamo, 5 per cent. on £250, £12. 10s.; proportion of wages, £26; 30 tons coal at 17s., £25. 10s.; oil and sundries, 5s. per week, £13. This is taking in both cases a large establishment with attendants already on the place. In gas lighting, the annual cost may be taken as directly proportional to the number of burners, because the rate is uniform and the cost of renewing burners and attendance are also proportional to their number; but with electric light this is not so. The items of wages, coal, oil, etc., do not bear a constant ratio to the number of lamps, but the larger the installation the more economical it becomes. The cost of gas and electricity for 250, 500, and 1,000 lights for the lighting of factories, shops, warehouses, and public buildings is also calculated. For mills and manufacturing works power can be obtained from existing engines, and the item for attendance in such cases would entail no addition to the wages sheet. Three different sets of circumstances affecting the lighting of buildings are thus typically considered, and a graphic representation is given with curves representing the cost of gas, electric light with special power, and electric light from existing engines. The curves would vary according to the cost of gas on the one hand, and of coal on the other; but with the data given the estimated comparative annual cost can be at once seen for an installation of any given size under the different conditions by examination of the curves. Allusion is made to the greatly increased economy of dynamos, and also of the method of transmission to a distance by means of high-tension currents and transformers, which now render electric lighting a commercially useful, economical, and trustworthy enterprise.

The British Museum.—The question of throwing open the Natural History Museum at South Kensington to the public at night has at last been definitely settled in the affirmative, and a pledge has been given by Mr. Smith to this purpose. It appears the Government had consulted the trustees of the museum, who considered that the Government ought to accept responsibility of the measure, and in face of this, the Government did not believe that such a step should be taken. On Friday night the Treasury Bench were at first inclined to postpone the matter, but Mr. Labouchere, who thought the Government, and not the trustees, ought to accept the responsibility, proposed an amendment to the British Museum vote to bring the matter to a point. Sir John Lubbock, as representative of the trustees, endorsed this view, and Mr. Smith thereupon assured the House tha the Government would offer no opposition if they could be satisfied that the trustees themselves had no misgivings. Sir John Lubbock gave this assurance, and Mr. Smith assented, upon which Mr. Labouchere withdrew his amendment. The throwing open of the museum necessitates, of course, the thorough introduction of electric light, as lighting by lamps or gas would not be considered safe. Writing to the *Times* of Nov. 19, Mr. Labouchere says: "With respect to this opening, I trust that the experiment will first be made in the museum proper rather than in the Natural History Museum at South Kensington, for the former building is more central, more interesting, and includes the reading-room, and that funds will be provided for a separate installation of the electric light. At present, I believe that there is no general installation which could provide the light; but even if there were, the initial expenditure on plant, about £12,000, would prove an ultimate economy, while for many reasons it is desirable that the installation should be under the direct control of the museum anthorities." The suggestion that the British Museum at Bloomsbury should first be lighted has weight from two reasons—namely, that the building is right in the heart of London, and can be easily reached by workmen, who would most appreciate the opening at night; and also that the electric light is already partially installed, and there would be little difficulty in arranging for an extension of the system under proper control throughout the whole building. There can, however, be no doubt that the lighting of the Natural His ory Museum would also be very greatly appreciated, and would more than double its interest and influence. We are extremely glad to be able to report this important step in the right direction.

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THE MAGNETIC FIELD.—V.

In the last article it has been shown how the field produced both by a straight and circular current can be mathematically expressed. Before, however, the formulæ there given can be practically applied, it is necessary to express the force exerted by a given field upon a given magnet-pole, in some measure comparable with the measures usually employed to define purely mechanical forces. The system of measurement universally employed in electro-magnetism is based upon the three fundamental units of length, mass, and time, and is generally spoken of as the C.G.S., or absolute system of measurement. The centimetre is adopted as the unit of length, the gramme as the unit of mass (not to be confounded with weight), and the second as the unit of time. On this basis the unit of force —the dyne—is a force capable of imparting to a mass of one gramme an acceleration of one centimetre per second. The acceleration produced by gravity (the weight of one gramme) is for our latitudes about 981cm., and consequently the force of one dyne is the $\frac{1}{981}$th part of the weight of one gramme measured in this part of the globe. If measured at the equator 977½ dynes would represent the same force as the weight of one gramme, and if measured at the pole the equivalent would be 982½ dynes. It is important to remember that the force represented by a given amount of matter, and which can be ascertained by a balance not subjected to gravity—say, for instance, by a spring balance —varies in different parts of the world. A piece of brass made of such a size that it shall exactly represent one gramme weight, if weighed on a spring balance in London will appear heavier if weighed on the same spring balance in Stockholm, and lighter if weighed at Calcutta. If it were practicable to adjust the carrying power of a magnet with perfect accuracy so that it may just support a given weight in London, it would fail to support the same weight in Edinburgh, and could support a small additional weight in Madrid. The elastic force of a spring and the attractive force of a magnet form correct measures of force in all places, whilst the weight of a body is not a correct measure. The variation is, however, so small, and the convenience of expressing a force in the usual manner by comparison with a weight is so great, that this method is almost universally employed. We speak of a force of so many pounds or tons, and tacitly assume that the weights representing these pounds or tons have been made and are used in our latitudes, and not at the poles or at the equator. On the same supposition we can conveniently express the magnitude of the force represented by one dyne as the $\frac{1}{981}$th part of the weight of one gramme.

After this slight diversion from the subject matter of these articles, we can now proceed to show how magnetic fields can be expressed in absolute measure so that the formulæ previously given may become practically applicable in the designing of electro-magnetic apparatus. We define unit magnetic field as a space in which the stream-lines are parallel, and the velocity of flow is such as to exert a force of one dyne upon a free unit magnet pole placed into the field. In the old notation, in which the strength of field is represented by the number of lines per unit space, the unit magnetic field is represented by a density of one line for each square centimetre of cross-section through the field. We have already, in the beginning of these articles, shown that the conception of any limited number of rigid lines is incompatible with a correct representation of experimental results, and have introduced the conception of a wind or stream of magnetic matter, the velocity of the stream in any point of the field representing the strength of the field at that point. We shall in future not use the somewhat cumbersome expression "velocity of magnetic matter following along the stream-lines" when speaking of the strength of the field, but shall simply substitute the term "induction," by which we mean the same thing, and which is already used by the adherents to the older method of expressing the strength of a field by the number of lines passing through one square centimetre of section. Thus, when we say that in a certain space there is an induction of 15,000, we mean that magnetic matter flows through that space 15,000 times as fast as through the space occupied by a unit field, or that according to the old notations there pass 15,000 unit lines of force through each square centimetre of that space.

We define unit pole as a pole of such strength that it will attract or repel a pole of the same strength placed one centimetre from it with the force of one dyne. Now we have seen that the same force is exerted by a unit field upon a unit pole, and it follows immediately that at every point of the surface of a sphere of one centimetre radius laid round the unit pole on its centre the strength of the field must be unity. The surface of the sphere is 4π, and the velocity at which the stream of magnetic matter passes through the surface is one centimetre per second. The volume of magnetic matter emanating from the sphere per second is, therefore, 4π cubic centimetres, and as this volume is originally discharged by the magnet-pole, we find as a second definition for unit pole the following: A pole from which are discharged, or into which flow 4π, cubic centimetres of magnetic matter per second. In other words, the total induction produced by a pole of unit strength that is emanating from one unit of magnetism is 4π; and the total induction produced by a pole of strength equal to m units is therefore

$$N = 4\pi m$$

Let a sphere of radius, r, be laid around the pole as centre. The surface of the sphere is $4\pi r^2$, and the induction, B, at any point of this surface must evidently be equal to the total induction, N, divided by $4\pi r^2$, or

$$B = \frac{m}{r^2}.$$

The force with which a pole of strength, M, is acted upon in a field of induction, B, is M B, and consequently the force of attraction or repulsion between two poles, m M, placed at a distance, r, is in dynes

$$F = \frac{m M}{r^2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

This formula, which can easily be verified by experiment, is generally taken as the starting-point in textbooks on magnetism. Here, however, we have obtained it as a result necessarily following from a consideration of the magnetic field surrounding a free pole.

The value of unit current can now be deduced by reference to unit pole and unit field. According to equation (4) the force exerted upon a unit pole in the centre of a circular current, c, of radius, R, is

$$F = \frac{2\pi c}{R}.$$

If the circle has a radius of 1cm., the force in dynes exerted by unit current is

$$F = 2\pi;$$

and, as 2π is the circumference of the circle, we obtain the following definition: Unit current flowing through one centimetre of a circular wire, having a radius of one centimetre, produces at the centre of the circle unit induction. The unit current adopted in practice—the ampere—is one tenth of the C.G.S. unit of current.

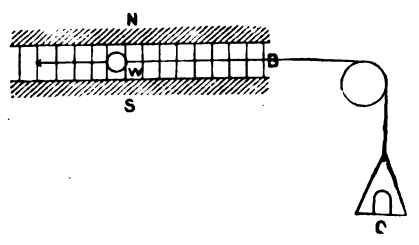

FIG. 10.

The unit of current and that of E.M.F. can also be defined in the following way: Let (in Fig. 10) N S represent the two polar surfaces of a magnet, producing between them a field of induction, B. Let w be a wire passing between these surfaces, and carrying a current, c, directed from the observer. The stream-lines of this current are circles surrounding the wire, and the flow takes place in a clock wise direction—that is, down on the right of the wire and up on the left. The stream-lines of the field flow all downwards, from N to S. Since stream-lines in the same direction

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repel and those of opposite direction attract each other, there will be a tendency for the wire to move to the left in the direction of the arrow. This force could be utilised in drawing up a weight, Q, representing a certain number of dynes. Now, suppose the wire begins to move, passing across the field with a velocity v, it will then do mechanical work on the weight, Q, by raising it, and the rate of doing work will be $Q v$ dyne centimetres (ergs) per second. At the same time, in virtue of the movement of the wire across the stream-lines (or, as it is usually expressed, in virtue of the wire cutting lines of force), an E.M.F. will be developed in the wire tending to oppose the flow of current, and more E.M.F. must be supplied from some external source in order that the strength of the current may not be diminished. This additional E.M.F., multiplied by the current, represents energy which must be supplied to the system in order that the mechanical work of $Q v$ ergs may be done upon the weight in raising it. Experiment shows that the E.M.F. developed in a straight wire which is moving across a field at right angles to the stream-lines is proportional to the product of current, length of wire, induction, and velocity, whilst the force is proportional to the current, length of wire, and induction. Let the strength of field be unity (B = 1), let Q be one dyne, and let the wire be 1cm. long, then the current must also be unity—viz., 10 amperes. For a wire l centimetres long, placed in a field, B, and traversed by a current, c, the force in dynes is

$$Q = l\,c\,B \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The E.M.F. called forth by a movement at a velocity of v cm. per second is in C.G.S. measure

$$E = l\,B\,v \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

The unit of E.M.F. adopted in practice, the volt, is 100,000,000 times as great as the unit in absolute measure, and therefore the E M.F. of the wire in volts is

$$E = l\,B\,v\,10^{-8}, \text{ and the amount in amperes}$$
$$C = 10\,c.$$

The work done per second, expressed in ergs, is

$$Q v = l\,B\,c\,v$$

and in watts

$$E\,C = l\,B\,c\,v\,10^{-7},$$

that is to say, one watt is equivalent to 10,000,000 ergs.

The equation (7) gives a definition for unit E.M.F. as that E.M.F. which is developed in a wire 1cm. long when moving at a speed of 1cm. per second across the lines of unit field. We also find from this equation that the E.M.F. generated in any closed circuit by virtue of a change in the total induction passing through this circuit is equal to the rate of change in unit time, as will be easily seen from the following: Imagine the ends of the wire, w, joined by a circuit, then some stream-lines pass through the coil thus formed, and others lie wholly outside of it. As the wire moves, a transfer of stream-lines from the inside to the outside, or *vice versâ*, takes place, the rate of transfer being $B\,l\,v$. The total induction passing through the coil may be due to the field, B, only; or it may also in part be due to other fields; but if the movement of the wire has no effect on the other fields, the E.M.F. is solely due to the change in the total induction due to the field, B. It is generally said that the wire in *cutting lines of force* becomes the seat of an E.M.F. which is proportional to the rate of cutting. The area of field swept over by the wire of length l, moving with a velocity v, is obviously $l\,v$; and since B represents velocity of flow along the stream-lines (or volume of magnetic matter discharged per second from each square centimetre of polar surface), the product, $B\,l\,v$, represents a certain volume of magnetic matter, or the integral of the induction, taken over the area which is swept over by the wire in unit time. In mathematical language, if N be total induction, the E.M.F. generated is equal to $\frac{d\,N}{d\,t}$, the differential quotient in respect to time that is the rate of change of induction. Expressed in volts, we have

$$E = \frac{d\,N}{d\,t}\,10^{-8} \quad . \quad . \quad . \quad . \quad . \quad (8).$$

It will be useful, because giving the students something definite as regards the magnitude of electro-dynamic phenomena, if we apply a numerical example to the apparatus represented in Fig. 10. The field of induction of B existing between the polar surfaces, N S, may be taken to represent the field existing in the interpolar space of an electromotor. The apparatus assumes, in this case, the form shown in Fig. 11, where the inner circle represents the cross-section

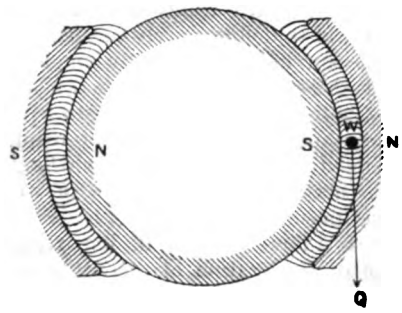

FIG. 11.

of the armature core, and the two segments on the right and left are the pole pieces of the field-magnet. We make at present no assumption as to the precise type of machine employed, and shall not enter into the question of how the field is produced. This will be shown later on. We merely assume that a field of a certain induction exists, and that the wire, w, is traversed by a given current. The problem is to find what force, Q, is required to keep the wire in its position. Let the armature be 50cm. long, and let a current of 100 amperes pass through the wire. Then, if B = 4,000, which is a moderate induction in modern dynamos or motors, the force, Q, is by equation six in dynes:

$$Q = 50 \times 10 \times 4{,}000$$
$$Q = 2{,}000{,}000,$$

or a little over 2 kilogrammes, nearly 4½lb. In English measure, each foot of wire traversed by a current of 100 amperes, whilst in a field of B = 4,000, exerts a pull of nearly 2¾lb.

ELECTRIC RAILWAYS.

We illustrate on next page the method adopted by the Thomson-Houston Company in applying their electric motors to tramway work. The dynamo used by this company for this work is a direct current dynamo, giving a current of 500 volts potential with an output of about 80 h.p. The motors vary in size from 7½ to 15 h.p., and, as will be seen, two motors are applied to the ordinary gear, each driving an axle through a short series of speed-reducing gearing. The following estimate as to costs of electric traction are obtained from a report by Capt. E. Griffin, of the engineer department of the United States Army, to the Board of Commissioners of the district of Columbia.

TABLE A.—*Construction and Equipment.*

—	Cost per mile, single track.			
	(1) Horse.	(2) Electric conduit.	(3) Electric overhead wire.	(4) Cable.
Track	$7,000	$7,000	$7,000	$7,000
Construction	4,000	2,000	6,000*	3,550
Cars, 4	3,200	2,600†	2,600†	3,600
Horses, 40	6,000	—	—	—
Conduit	—	20,000	—	40,000
Steam power plant	—	2,000	2,000	2,500
Dynamo	—	2,000	2,000	—
Motor trucks	—	4,800	4,800	—
Total	$20,200	$40,400	$23,000	$56,650

* Including poles and wire. † Without the trucks.

Of course this estimate must be modified according to the place where the tramway is intended to run; still, we think the comparisons should hold good, and these show that

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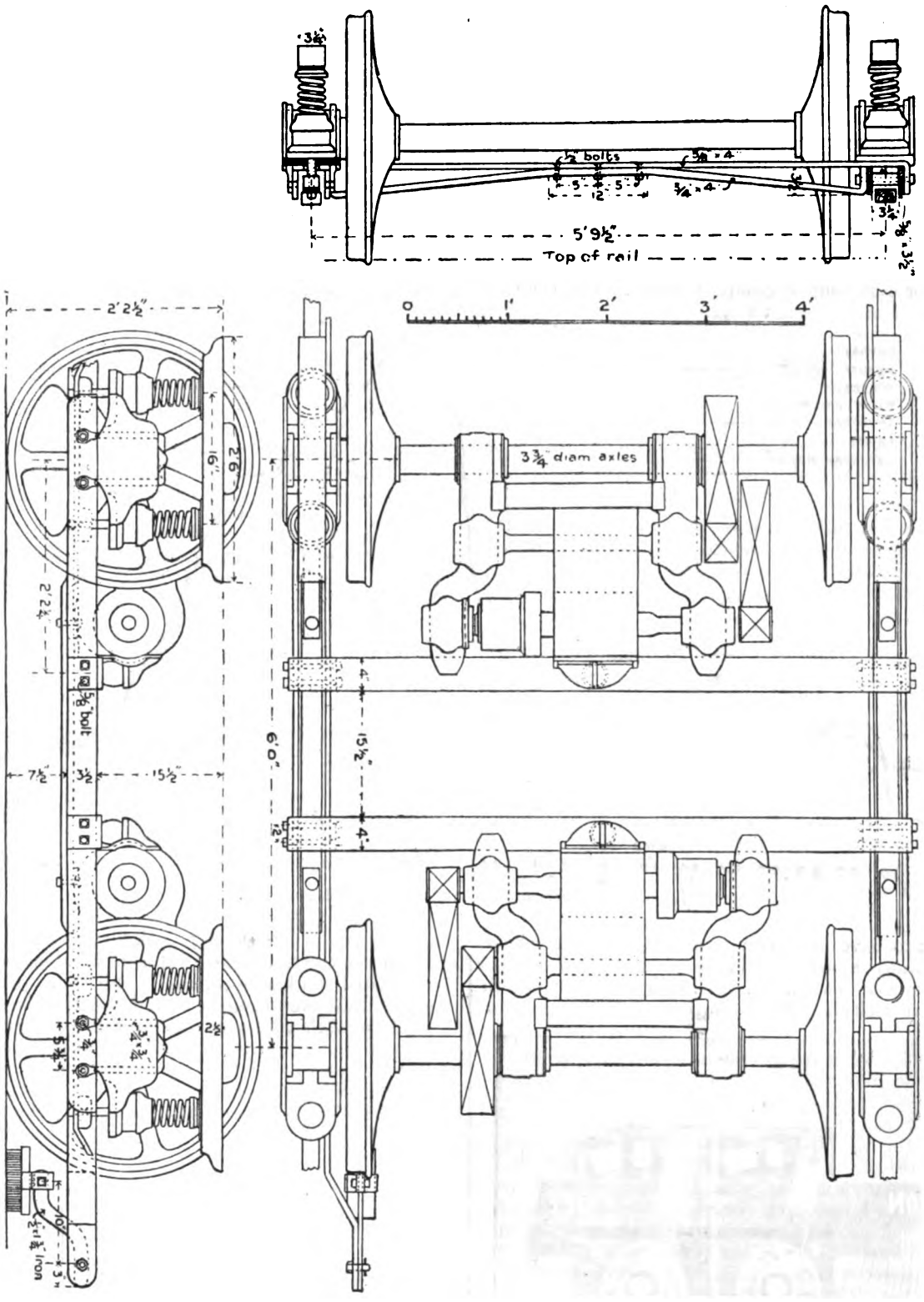
with overhead conductors the initial cost per mile of single track for construction and equipment is little more than that for horse traction, while the conduit system is double that for horse traction, and the cable system has a higher initial cost than any of the others. Table B shows Captain Griffin's estimate for the annual running expenses per mile.

Taken per car, the cost of operating by the electric car for 16 hours per day, at an average of 5 h.p., is from 1.75dols. to 2.50dols per day, and this rate is from one-third to one-half the cost of operation by horses.

Taken per car mile, the cost of operation of electric rail ways is from 1½ cents to 5½ cents, as compared with 10 cents operated by horses.

The performance of electric cars as to speed is from about the rates usually developed by horses, or seven to nine miles per hour up to 15 miles per hour. The rate upon grades as heavy as 9 or 10 per cent. has been from four to seven miles per hour.

The cost of construction and equipment for the storage system includes the special expense for accumulators—880 at 12dols. = 1,056dols. per mile, and the total is estimated at 38,560dols. per mile. The running expenses include the cost of renewals of cells (352dols.), and are estimated at 8,862dols. per mile annually. The advantages of this method are—ease of conversion of ordinary horse railroads into electric roads; the independent action of each car, which carries its own motive power; and the avoidance of new constructions along the line of road, together with ease of extending the method on any routes where needed. On the basis of the above estimate, the storage system costs slightly less than the conduit for construction, but the running expenses are greater than those



Thomson-Houston Motors applied to Tramcars.

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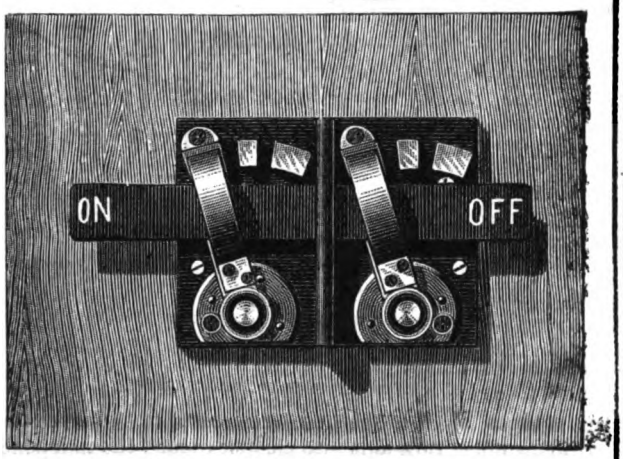
for the cable system, but 17 per cent. less than for the horse-car road.

TABLE B.—*Annual Running Expenses per Mile.*

—	Horse.	Electric conduit.	Electric overhead wire.	Cable.
Feeding, replacing, etc.	$8,760			
Depreciation, 5 per cent., and maintenance	710	$1,576	$920	$3,900
Interest	1,212	2,424	1,380	3,400
Coal.....	—	775	775	958
Wages, engines, etc....	—	250	250	250
Total	$10,682	$5,025	$3,325	$8,508

THE GROSVENOR GALLERY INSTALLATION.—III.

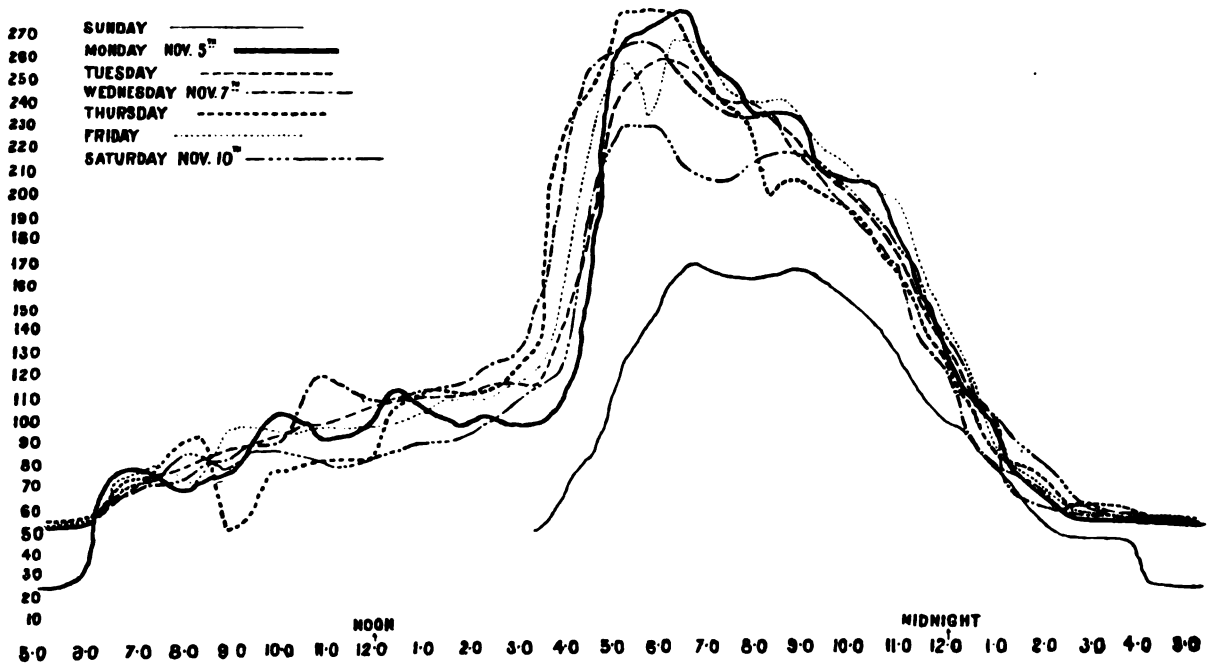
In the private installations worked from the Grosvenor Gallery each house has, of course, its own high-tension switch for the primary current, besides low-tension switches for each lamp or group of lamps. The company prefer not to have any main switch upon the secondary cables, nor any secondary main fuses, relying rather upon the primary main switch and fuse, which will cut out the transformer itself as well as the lamps on the secondary



Grosvenor High-Tension Switch.

circuit. The double-pole main switch for the primary circuit is shown in the cut, with the wooden case and glass cover removed to show the action more clearly.

The load diagram of the whole work is drawn each day, by the engineer in charge, from the half-hourly readings on the ampere-balance, and forwarded to the central office. By the courtesy of the secretary, Major Waller, we are enabled to reproduce a series of these diagrams, representing one week's work, superposed so as to show the corresponding curves for the various days of the week. Perfect record is thus kept of the output at any hour, and any increase and variation can be at once noted by inspection, and kept for future reference.



Load Diagrams for one week at the Grosvenor Installation.

A FEW POINTS ABOUT SPARKING

BY L. W. SERRELL, JUN.

As the title might be taken by the romantic to refer to something occasionally mentioned in country ballads, which might seem out of place in a technical journal, I would say, both in justice to the editors and myself, that I refer merely to that troublesome occurrence which makes the commutators and brushes on our dynamos and motors so short lived.

Frequently our dynamo and motor tenders who take pride in keeping their machines looking clean and neat, and who try so perseveringly to keep the dull glossy look on their commutators which betokens an absence of spark, are irritated and harrassed, after a half hour spent in trying to adjust their brushes, to find that they have not succeeded; or if they do succeed, and walk away with an air of satisfaction regarding their work, they return a few minutes later to find their machine sparking as badly as ever; but if they are observant they will notice that the return of the spark is always accompanied by a change of load.

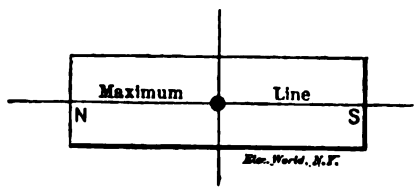


FIG. 1.

Why should this produce sparking? By a shifting of the neutral line? And if so, what should cause the neutral line to shift? Let us see.

Suppose we have two bar magnets, Fig. 1, placed one on top of the other with their north poles and their south poles together. The maximum line will be in the direction of their length, while the minimum line will be at right angles to the same. Fig. 2 shows the upper magnet rotated through an angle of 90deg., in which case, if the

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poles be of equal strength, the maximum line will bisect the angle included between the magnets, the neutral line being at right angles to it, as before.

It is evident that if one magnet be weaker than the other, the maximum line will divide the angle, A O C, inversely proportional to the strength of the magnets.

Letting S = the induction of the magnet N S; S′ = the induction of the magnet N′ S′, we obtain

$$S : S' :: \frac{1}{\angle BOC} : \frac{1}{\angle AOB} \text{ or, } \frac{S'}{S} = \frac{\angle BOC}{\angle AOB}$$

Now if N′ S′ were an electro-magnet, so arranged that its strength could be varied, the maximum line would change its position with every variation in the strength of the magnets, and consequently cause a shifting of the neutral line.

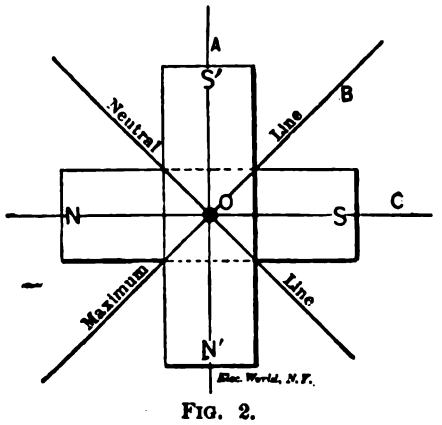

FIG. 2.

The action is similar in our dynamos and motors. Fig. 3 represents a pair of pole-pieces with their maximum and minimum or neutral line in the position shown, and Fig. 4 represents an armature ring with the brushes in the position shown, the poles being formed where the current enters, causing the maximum line to coincide with a line through the point of contact of the brushes. Now, if the armature be placed between the fields, as shown in Fig. 5, the line of maximum action will depend upon the relative inductions of the field-magnets and the armature, and will assume a position approximating that shown in the figure, while the neutral line will be at right angles to it, as before; consequently the brushes should be adjusted to this position. The position which the resultant neutral

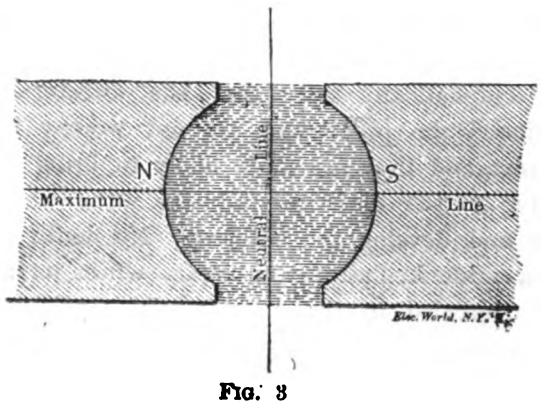

FIG. 3

line takes either forward or backward from the neutral line when the fields alone are considered is commonly known as the magnetic lead or lag.

In constant potential dynamos and motors, when simply shunt wound, we have a constant field. The amperes of current flowing through the armature proportion themselves to the load upon the shaft, while the position of the neutral line depends upon the induction in the armature, and is determined by the ampere turns of wire upon the same, being shifted with every variation of current which accompanies every change of load; hence we have a case similar to the permanent magnet and electro-magnet before cited.

The induction in the armature can only be diminished by using fewer wire turns upon the same, as a certain number of amperes must be supplied under a certain pressure to develop a given amount of power; consequently a machine properly designed, in which the sparking shall be a minimum, must have the strongest possible field which can be produced, while the iron in the armature core must have sufficient area of cross-section to conduct these lines of force below its saturation point. Under these circumstances we obtain an armature of low resistance, a machine of high efficiency and excellent regulation.

In constant current dynamos and motors, in which the strength of the field is varied while the armature has a constant induction, it is much more important to make the wire turns on the armature as few as possible; for if we diminish the strength of the more powerful field-magnets, the ratio of the armature induction becomes greater and greater, causing a considerable rotation of the neutral line. Those who have seen dynamos and motors running on constant current circuits have always been impressed and frequently wondered why they should spark so much more than the incandescent machine. Why not build these machines with a constant field and regulate the volts automatically in the armature?

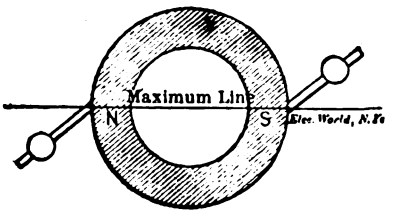

FIG. 4.

I am aware than many people believe that the position of the neutral line will be changed by a change of speed, but experiment proves that when the current in the armature is constant and the strength of the field remains the same, a change of speed has no effect upon the position of the neutral line.

By referring to Fig. 5 we see that by shifting the brushes into position at the neutral line of the combination we also shift the poles of the armature, and consequently change the position of the line of maximum action, causing the neutral line to rotate still farther back. This repeats itself each time we shift the brushes, so that,

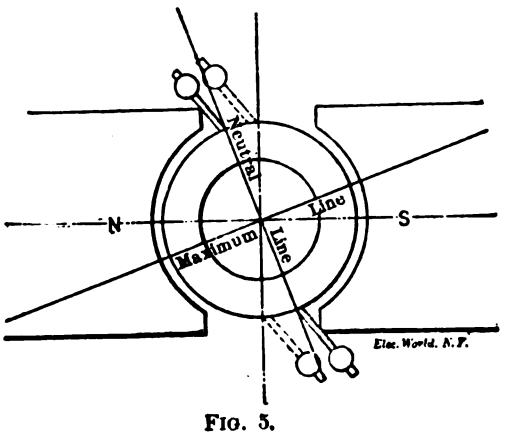

FIG. 5.

theoretically, it is impossible to place the brushes on the neutral line; but the fact that the brushes have thickness and cover quite a little of the periphery of the commutator makes its possible, if the machine be properly designed, to run with absolute freedom of spark under all variations of load within the capacity of the machine.—*Electrical World.*

India.—With reference to our question as to lighting plants for India, Messrs. Woodhouse and Rawson, Limited, inform us that they have recently shipped a complete lighting plant to Mysore, for the lighting of the palace of the Maharajah, and one of their engineers left yesterday for India (per ss. "Bengal") in order to install the same.

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BOUND VOLUMES.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

WHAT IS FAIR IN CONTRACTING?

The motto of the business man might well be taken from the witches' scene in "Macbeth":

"Double, double toil and trouble"

especially if he has to provide against such contingencies as may be evolved in the following description of work recently contracted for. We are not absolutely certain as to some of the details of the operation, but the broad facts of the case are, we believe, beyond dispute. One of the large companies promoted this year, presided over by an array of directors of sufficient renown, and enough in number, to stock a continent, decided to ask for tenders for a large installation. Nothing, so far, could be more straightforward, nothing more could be asked. The time allowed for sending in the tenders came to an end, and the tenders were duly deposited. Contractors anxious for the work waited the result of opening and deciding the tender, when their hopes were dashed to the ground by a decision to postpone the matter for a month—one little month. A harmless enough decision, many will say, but thereby hangs a tale. From this time forth and for ever, no action of this company will ever be taken as satisfactory. All the explanations in the world will never get business men to believe these proceedings to have been clear and above board. The month's delay seems—we say seems advisedly, because we cannot prove it—to have been made with the sole purpose of allowing Westinghouse to lodge a competitive tender. This tender was successful, and so Westinghouse has obtained the largest installation in London next to Deptford. We do not object to Westinghouse getting a contract—we object to the method pursued in this instance. We care not to ask their reasons, we care not to know the arguments used to obtain consent; we most emphatically state that the directors who sanctioned the proceeding are not worthy to be directors, and they are more likely to bring about disaster to the electrical industry rather than to foster and develop the industry. No doubt there was a minority, strong or weak, whose opinions were overruled in this matter. We apologise to this minority for classing them with men whose tactics are unworthy of any business fraternity, but so far the promotion, the floating, and the work of this company will hardly bear the light of close scrutiny. As we have hinted above, unless someone from behind the scenes discloses the facts, we cannot say whether the amounts of the tenders sent in could or could not have been made known in America. So far as the time element comes in, every figure and every detail could have been sent over by post, and time enough given for the consideration of these facts and figures, and the return of the tender which proved so satisfactory. There is nothing to indicate in the transaction but

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that Westinghouse and all connected with Westinghouse have acted perfectly right in the matter. It was purely a question of business to get delay and to get information, if possible and if required. There is no business house existing but would like to know, if it could get the knowledge in a legitimate manner, the prices at which its competitors were tendering. This knowledge does leak out occasionally, and travels by the purest accident where it is wanted to travel—at least that is the way it is stated; yet, upon enquiry into these cases, there always appears to be an inscrutable laxity among the directors or the officers that is hardly to be accounted for by the ordinary rules pertaining to such business. Directors have even been known to be cynical enough to say, "Our business is to buy as cheaply as possible, and if Brown will underbid Jones, why should not Brown know Jones' price?" That is all very well from the cynic's point of view; but why should Brown be given gratuitously—usually he is not—what it cost Jones a hundred pounds to obtain? If the original intention is to play off Jones against Brown by heavily handicapping Jones at the start, it is but fair to say so; but the director who does this sort of thing is quite keen enough to know the dictum of Bret Harte applied to the heathen Chinee, applies also to him:

While I wish to remark,
And my language is plain,
That for ways that are dark
And for tricks that are vain
The heathen Chinee is peculiar.

Perhaps the directors of the "Metropolitan" will condescend to explain their action. Be this as it may, explanations and regrets will never get rid of the facts, and though it may be contended that what has been done, has been done and cannot be mended, the transactions should be paraded in the full light of day, so that men may know with whom they have to deal, and act accordingly. In our opinion, the time originally appointed for sending in tenders should be rigidly kept, and no new tender should on any account be accepted after that time, and most certainly not after the lapse of days and weeks. If it is desirable to have new tenders, some remuneration should be made to those who have complied with the original conditions, their tenders should be returned unopened, and they have full liberty to send in revised tenders at the expiration of the extended time.

THE INSTITUTE OF ELECTRICAL ENGINEERS.

The proposal to change the title of the "Society of Telegraph Engineers," etc., to the "Institute of Electrical Engineers" is *un fait accompli;* but there are one or two burning questions still before the council, one at least of which will probably have to be decided by the members. After a fair trial of the present system of electing the council, there is a decided opinion in favour of reverting to the old plan. At present the council issues a "house list," containing the names of more than are required, and the members select from the names thereon those who shall represent them during the year. A certain number of gentlemen whose names are upon this list cannot, of course, be elected, and it has been found that many very desirable names have to be omitted, because the gentlemen will not subject themselves to the perils of a popular election. Another misfortune is, that gentlemen who have not been elected do not take so great an interest in the society as heretofore, and it can be well understood that men of prominent rank may have a feeling upon them that their efforts in relation to science and its applications are not appreciated by the society. We have every reason to know that the council desires to make that body representative of the various sections of the society, and it may well be that the best man to represent a certain section of the members is unknown to those who so far take an active interest in the society as to record their vote.

Considering, therefore, all sides of the question, we should not feel disposed to oppose the going back to the old system, provided that it was made clear to the members that any one or any section of the society might suggest a name or names to be placed upon the house list. The council is, after all, a limited body, and some of the members might have strong reasons for desiring a special representation. Such suggestions ought not to be pooh-poohed by the council without due consideration, and we venture to believe they will not.

As the "Institute," we commence a new era. The title is comprehensive enough to include all sections of workers—hence it is all the more desirable that if the views we have alluded to are correct, the council should be given a free hand.

CORRESPONDENCE.

INDIAN PATENTS.

To the Editor of the Electrical Engineer.

Sir,—Slowly, but surely, the British colonies follow the example of the mother country, and adopt laws preventing fraudulent marking of goods.

The Indian Government has now introduced a Bill to come into force on the first day of April next, and of which the following are the chief provisions.

The Bill defines "trade marks" and "trade descriptions" in accordance with the universally accepted meaning, and states a "false trade description" to be one that is "untrue in a material respect as regards the goods to which it is applied," whether it has been false when applied or rendered so by subsequent alteration.

The Bill differentiates between "trade marks" and "property marks" as follows: "A mark denoting that goods have been made or manufactured by a particular person, or at a particular time or place, or that they are of a particular quality is called a trade mark," and includes marks that are registered out of India.

"A mark used for denoting that movable property belongs to a particular person, is called a property mark."

Whosoever marks any "goods or any case, package, or

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other receptacle containing goods," or uses "receptacles so marked as to mislead as to time or place of manufacture, or as to the quality of the goods, etc.," is said to use a false trade mark, and shall, unless he proves that "he acted without intent to defraud, be punished with imprisonment of either description for a term which may extend to one year, or with fine, or with both."

Whosoever counterfeits such marks, or knowingly uses as genuine a counterfeit mark, or has in his possession any "die, plate, or other instrument for the purpose of counterfeiting" any such marks, is made punishable with imprisonment up to three years, or with fine, or both.

Whosoever sells or exposes for sale goods that are falsely marked, shall, unless he proves his good faith and discloses the source whence he obtained the goods, be liable to imprisonment for one year, or to a fine, or both.

The application of a "name or initials (*a*) not being a trade mark or part of a trade mark, and (*b*) being identical with, or a colourable imitation of the name or initials of a person carrying on business in connection with goods of the same description, and not having authorised the use of such name or initials," is deemed a false trade description.

The definition of "application" of a mark or trade description to goods is most exhaustive, and seemingly sufficient to cover the entire ground.

Saving clauses are inserted for the protection of those who act inadvertently or in ignorance. Provision is made for the forfeiture of goods falsely marked, and for the intervention of the Customs' officers. This Bill makes no difference in the manner of registering trade marks in India, but is meant to correspond with the British Merchandise Marks Act.

Trusting that this information will prove useful.—Yours, etc.,

BERNHARD DUKES,
226, High Holborn, London, W.C. Patent Agent.

REPORTING PROGRESS.

A new feature is rapidly being added to the variety of work in London streets in the laying of electric light mains. How engineers must curse *sotto voce* because of the non-existence of subways in our principal streets. No doubt, when the millenium arrives, it will be found advantageous to build subways and rent out to users. Now, every new departure means taking up the streets and interfering with all that rests therein. One advantage of electric lighting, however, will be that the streets in which the mains are laid will not be contaminated with the stinking leakage that now emanates from the gas-pipes. Visitors to the National Gallery will this week have seen the work going on by Messrs. Callender in laying the mains for the Metropolitan Company. The work commences at the further end of St. Martin's Church, crosses the road, and continues in front of Morley's Hotel towards Northumberland-avenue. A stiff piece of work has to be done in crossing the top of the Strand, but so far no great difficulty has been encountered. Twelve mains are laid in the bitumen casing about two and a half feet deep. Test boxes are built at various points, so that tests or repairs can be made over sections. The mains are not yet drawn in, but lines or wires run through the casing with which to draw them in. Altogether, the work seems well done.

In taking a look round at various central stations in London we may see great extensions being undertaken in those installations already established, and preparations rapidly coming to a head of the numerous new undertakings. The St. James' Electric Light station, a plan of which we gave last week, is being rapidly pushed forward, the chimney-shaft is rising, and the foundations, smoke-shafts, and construction for reception of boilers, etc., are well in hand. It is expected that the place will be ready for reception of the machinery by Christmas. The boilers for this installation are some of the largest Messrs. Davey, Paxman have made, and would have been made still larger but for the fact that all machinery has to pass through a comparatively narrow passage into Mason's-yard, and the boilers had, therefore, to be built to pass through this passage. The distributing cables for this installation will be run in underground conduits, all necessary parliamentary and local authority having been obtained for permanent laying of the cables.

The Chelsea Electricity Supply Company have begun clearing the ground of the old cottages now upon it at the back of Cadogan-square, where their central station is to be constructed. We shall give particulars of this installation as the work progresses. The company have now temporary offices at 37, Sloane-square. The large number of new residential buildings and flats in this locality should guarantee a steady and increasing demand for the new light under the best conditions for consumers.

The Cadogan electric light station, which will be interesting at this moment on account of the paper read last night by Mr. Edmunds, describing his method of distribution, is rapidly extending its operations. There are now some 2,500 lights connected—the large drapery stores of Mr. Peter Jones, King's-road, Chelsea (500 lights), and Messrs. G. Trollope and Sons, Hackin-street West (300 lights), being the latest additions to the circuit. Mr. Reuben Sassoon is the largest private consumer, his house being fitted with 350 lights. The system here employed, in short, is that of series charging of accumulators, each house having its own set of cells, with special details for continued charging and supply. The latest type of E.P.S. accumulators are used, 31-L type, 700 ampere-hours capacity. The number of cells in each installation varies from 8 to 64, according to the size of the installation. The cells are arranged in four sets, three sets only being used for supply of the lamps. A small motor changes the sets of cells in rotation by means of a switch, at intervals of one, two, or three minutes, as may be required, one of the four sets being thus charged at equal intervals for equal periods. As all four sets for a brief period are on the lamps, a special resistance is simultaneously placed in series with them, to keep the pressure of the lamp-mains constant. The circuit cable, 19-14 strand, by Glover and Co, is run in a simple series, mainly overhead, reaching to Belgrave-square, and is now over eight miles long. It is suspended from a seven-strand steel wire, with standards at intervals of about 70 yards. Three Armington and Sims' engines of 50 h.p. are now at work, with three dynamos of the Leeds pattern, made by Greenwood and Batley. One peculiarity of this installation is that the dynamos are separately excited from a set of accumulators. The lighting from this station is rapidly extending, some 3,000 more lamps being wired ready for connection.

PROPOSED PACIFIC CABLES.

A meeting in furtherance of this scheme was held yesterday (Thursday) at the Cannon-street Hotel, the Earl of Winchelsea presiding. It is not necessary to report at length this meeting, which was, so far as its promoters were concerned, mainly explanatory and an amplification of the subjoined letter. The views of the opponents to the scheme are given in Mr. Hesse's letter, also to be found below.

The subjoined letter from the Pacific Telegraph Company, Limited, sent a year and a half ago to the chairman of the Colonial Conference conveys a proposal to lay a cable from Vancouver Island to Australia:

"34, Clement's-lane, London, E.C., May 3, 1887.

"Sir,—Referring to the proposal submitted by the Pacific Telegraph Company for the consideration of the Colonial Conference on the 20th of April, 1887, I am now instructed by the directors of the company to submit as an amended proposal the following:

"1. The Pacific Telegraph Company shall lay a line of cable from Vancouver Island to Australia, touching at Hawaii, Fanning Island, Samoa, Fiji, and New Zealand.

"2. The Governments of Great Britain, of Canada, and of the Australasian Colonies shall guarantee to the Pacific Telegraph Company Government traffic to the amount of £75,000 per annum, in such proportion as may be mutually agreed upon by the said Governments.

"3. The above guarantee shall date from the completion of telegraphic communication between Canada and

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Australasia by the company, and shall continue in force for 25 years from that date, subject to the following conditions:

"4. In the event of telegraphic communication being interrupted, 35 days shall be allowed to the company for repairs; if at the expiration of 35 days telegraph communication shall continue to be interrupted, then the guarantee shall be suspended from that date until telegraphic communication be re-established.

"5. The rate per word payable by the Governments shall be the current rate charged by the company to the general public, but such rate shall never exceed 4s. per word for the transmission of messages from England to Australasia.

"In my statement to the Colonial Conference on the 27th of April, I mentioned that the proposal of the Pacific Telegraph Company which was then before the conference, for an annual subsidy of £100,000 for 25 years, was based upon calculations as to the approximate cost of constructing and laying a cable which were made some time ago.

"I further stated that the company was at that very time actively engaged in collecting expert evidence as to the most recent improvements in the manufacture of cables and the consequent reduction in the cost of constructing and laying them. The result of investigation has been to convince the directors that the original estimates for the cost of the undertaking will bear some reduction.

"In addition to the above, the directors have been influenced by considerations of even greater weight. Events of very recent date point to the certainty of the Pacific Ocean being shortly developed as one of the main waterways of the world's commerce. In view of the very largely increased intercolonial telegraphic traffic which must inevitably follow any such development, the directors feel justified in accepting the extra risk which the reduction of the guarantee from £100,000 to £75,000 per annum will entail.

"As above stated (in clause 5), the directors of the Pacific Telegraph Company bind themselves to start by reducing the rate to 4s. per word for the transmission of ordinary messages from England to Australasia, and further bind themselves not to exceed such rate. The reduction to 4s. per word, however, is by no means intended to be final, for if the estimates of increased traffic are in any way realised the company will be in a position to effect very considerable further reductions.—I have the honour to be your obedient servant,

"HAROLD FINCH HATTON, secretary."

The Secretary of the Eastern Extension wrote in answer to this as follows:

"The circular sent out by the Pacific Telegraph Company, convening a meeting, to be held on the 22nd inst. at the Cannon-street Hotel, to consider and pass a resolution in favour of their proposal for laying a cable from Canada to Australia, contains the following statement, namely, that 'the extremely unsatisfactory state of the existing cable communication between England and Australasia is injurious to trade, and would be a source of great danger to imperial interests in time of war.'

"In thus endeavouring to disparage the existing communication, the Pacific Telegraph Company doubtless hope to further the objects they have in view, but as the statement is most exaggerated and misleading, my directors trust you will find space in your valuable paper for the following remarks, in order that any false impressions created in the minds of those attending the meeting may be removed, and that the telegraphing public may have both sides of the question before them:

"The existing communication with Australia was established by the Eastern Extension Company in 1871, without subsidy or assistance of any kind from the colonies or the Imperial Government, and, subsequently, when the importance of telegraphy became more fully realised, and a duplicated system a public necessity—not because a single line was unequal to the transmission of the traffic, but in order to provide against the interruptions inseparable from a single line of cables—the colonies of Victoria, New South Wales, South Australia, and Western Australia agreed to give the company a subsidy of £32,400 per annum for 20 years, to enable it to duplicate the cables between India and Port Darwin. Since then the telegraphic communication has been very seldom interrupted, a result due to the duplication, and in some sections triplication, of the cables, and to the fact that they are laid for the most part in shallow water, and are consequently repairable at almost all seasons of the year.

"Unfortunately, during the past few months the communication has been thrice interrupted through exceptional circumstances, and the public, not adequately appreciating the enormous difficulties and expense inseparable from the efficient maintenance of submarine telegraphy, have made little or no allowance for the same. On the first occasion both the Java-Australian cables were suddenly and simultaneously interrupted in deep water through volcanic disturbances, and the two subsequent breakages were in connection with the renewals of portions of the cables where they were found to be on bad ground and in dangerous proximity, owing to the strong currents off Java having drifted them together.

"The total interruptions, however, since the communication was duplicated in 1880, including those above-mentioned, have aggregated only 41 days, averaging less that five days per annum, a result that will bear favourable comparison with the working of any other submarine system in the world.

"In order, however, to further strengthen the system, the company are about to lay a third cable from Java to Australia, which, by working with the Western Australian land lines, will give the colonies the advantage of an alternative land connection *viâ* Perth and Eucla to the existing overland line between Port Darwin and Adelaide. Consequently, the colonies will be provided with a complete and efficient telegraphic service by the existing system, not only equal to the transmission of a much larger traffic than it now carries, but enjoying the immense advantage of being under English control and worked by English operators throughout its whole length.

"My directors would therefore submit that the existing company, as the pioneer of telegraphic communication with Australasia, is entitled to consideration at the hands of the colonies.

"With regard to the reflections made by the Pacific promoters as to the insecurity of the existing communication in time of war, I am directed to point out that while the route between Australia and Java and Europe is incomparably the most secure and easily protected in time of peace, it would be the most surely and easily safeguarded in time of war, inasmuch as it is one of the sea routes most frequented by the mercantile marine, and would therefore be the special object of the vigilance and care of the Royal Navy.

"On the other hand, it would be impossible for the British Government, however anxious to do so, to provide adequate protection in the case of cables laid across the Pacific, far away from the routes used by commercial ships, and at immense distances from coaling stations, and, moreover, a single line of cables consisting of long stretches across such enormous depths at those recently reported to have been found by H.M.S. "Egeria" off Fiji—namely, 4,295 fathoms and 4,430 fathoms (five miles deep), and terminating on coral reefs, would inevitably be exposed to frequent interruption, which would render its maintenance most costly and difficult. It should also be borne in mind that the Canadian Pacific land line, passing as it does through exposed and stormy regions, would also at certain seasons of the year be very difficult to maintain.

"The question, however, is, are the public prepared to find the necessary money for a Pacific line? If so, they must make up their minds to an expenditure of nearly four millions sterling for a duplicated service. This large expenditure, however, is in no way justified by the existing traffic, which only gives a moderate return upon the capital already invested, and, consequently, the additional outlay would prove altogether unremunerative.

"The proposal made by the Pacific Telegraph Company that Government traffic should be guaranteed to the amount of £75,000 per annum for 25 years is not so favourable to the colonies as it would at first sight appear, as the whole of the traffic at present exchanged by the Imperial and

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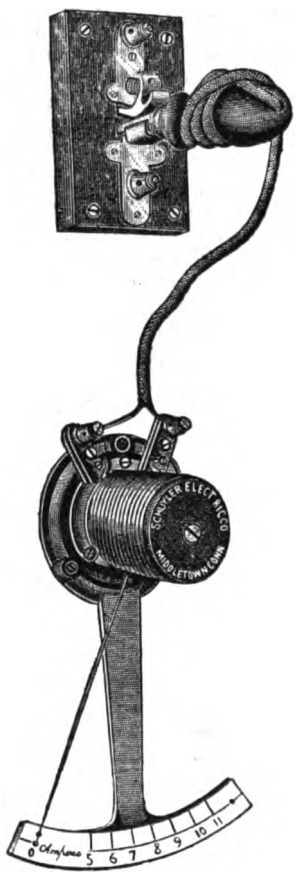
Australasian Governments represents less than £16,000 per annum, and consequently the Governments would have to extend their expenditure by about £60,000 per annum to make up the amount of guarantee.

"If, however, the colonies are in earnest in their desire to have cheap tariffs, the object can be easily attained by adopting the guarantee proposal submitted by the Eastern Extension Company to the Imperial and Australasian Governments last year, by which the colonies might make the tariff any figure they please, provided the Eastern Extension and its associated companies were guaranteed three-fourths of their present moderate earnings from the Australasian traffic, the companies accepting the remaining one-fourth of the guarantee risk. This would give the colonial Governments full control over the tariffs, and in our opinion enable them to establish a cheaper rate on more favourable conditions than could be obtained in any other way."

THE SCHUYLER AMMETER.

A very simple form of ammeter, shown in the illustration, is employed by the Schuyler Electric Company, of Middleton, Conn., U.S.; and, by its handiness and the fewness of its parts, has a general air of the American style of cheap and useful inventions now well known in all



departments of life. It consists in the simplest arrangement of a coil acting upon an armature attached to a spring, which moves a pointer over the scale, which is marked upon the extension of frame of the coil. Connection is made in an ingenious and convenient manner by raising a spring contact by a wedge connecting-piece attached to a flexible cord. These ammeters are calibrated to read directly in amperes.

SIEMENS SMALL ELECTROMOTORS.

We have already given some details as to the number of motors at present at work in Berlin, with the uses to which they are, and the prices at which they are supplied with power. We reproduce from the *Electrotechnische Zeitschrift* some illustrations of these small motors, which are made by Messrs. Siemens and Halske, and are supplied to furnish the small power of $\frac{1}{10}$th h.p. and upwards for various household and industrial purposes.

These motors are wound for use on the incandescent or arc circuits, and are constructed with the pole-pieces in the form of a ring. Fig. 1 shows the usual form for a hair-dresser or lapidary, etc., or for working sewing machines.

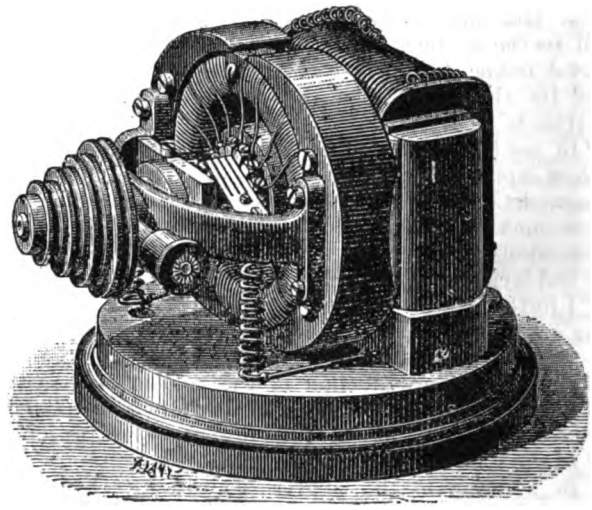


Fig. 1

Their use has already assumed considerable proportions in Berlin, and their simplicity and good construction have rendered them very successful.

SPECIFIC GRAVITY INDICATOR.

We have already alluded to the specific gravity indicator for use with storage cells used by the E.P.S. Company. The cut shows the appearance of this indicator, which is proving itself very useful to users of accumulators. The glass containing tube is pierced for circulation of the liquid, and the rise or fall of the small bulbs, each of which are coloured differently, indicates to the eye at once the state of the battery solution. The indicators are made by Messrs. J. G. Hicks, of Hatton-garden, who have had some difficulty in turning them out fast enough for the demand. A simple indicator such as this commends itself specially in cases where the installation has to be put into the hands of untechnical persons, such as gardeners and handy men, as is very often the case in private house installations in the country. For these a delicate chemical instrument, like a graduated hydrometer, is rather out of place. Even to persons undertaking accurate tests, where the hydrometer is in constant use, these little indicators will also save a good deal of trouble, as a moment's inspection of the coloured bulbs serves to show approximately the condition of the cells.

NOVEL REFLECTORS.—A wrinkle may be taken from the experience of an electric light man who lately had to light up Buffalo Bill's show. The arc lights were not sufficiently concentrated to enable the crack shots to see the glass balls, and it was necessary to have some kind of a focussing apparatus. He first tried locomotive head lamps behind the six lamps in the grand stand, but these were a failure. As an emergency he sent for a dozen ordinary new dish pans, and these were nailed up behind the lamps, and the result was astonishing. It was a great success. Ninety-five more were placed behind the pole lamps, and the result was a perfect illumination.

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ELECTRIC TRAMWAYS.

(*Continued from page 411*).

Mr. F. J. Sprague: I feel somewhat at a loss in addressing you upon this subject. I do not wish to urge any particular methods of working, except so far as they bear my name. By that I mean I do not present either the storage battery, the overhead or the conduit system alone. Each of these three systems has its merits, and each of the three will succeed, as each of them has its own independent field of work. There are some planes where the cost of each of any two of these systems meet. The experiments which have been carried on during the past year have proved what electricity can do. We have been, possibly by good fortune, perhaps by hard work, somewhat prominent in carrying out these experiments. One year ago to-day we did not have an electric road running in the United States except one car in the East Boston Sugar Refinery. On the second day of last February, the Richmond road, of which I spoke to you at the meeting last year, was opened. This is a road which, whatever its defects, stands to-day somewhat historical in the fact that it is the largest, and the first large successful electric railway in existence. When the contract was made a year and four months ago, not a foot of track had been laid, and we did not know what we had to meet in the grades or curvatures on the road. The specifications did not give the grades with any accuracy and only in a very general way. We took the contract simply because we saw an opportunity to develop on a large scale the possibilities of electric traction by our overhead single-wire system. Twelve miles of track, including switches and turn-outs with twenty-nine curves were laid; straight grades were met as high as 10 per cent., and grades on curves of 40ft. radius as high as 7, 8, and 9 per cent., giving a straight track equivalent of at least 13 per cent. On the 2nd of February the road started, and since then it has made nearly five hundred thousand miles and carried nearly two million passengers. The road is no longer under our control; it has been bought and paid for. The cars have been run as high as eight thousand miles without being sent inside a car shed. This is extraordinary in view of the fact that the cars have no proper care, but are for the most part housed in the streets. The motors have been run without any covers on them; they have been run until you could hardly identify a motor, it was so covered with dirt and slime. Yet under all these disadvantages, these motors have, as I said, many of them made records as high as eight thousand miles without even being properly cleaned. The motors which are in use in Richmond were never designed for the work they do. They were designed to operate up to 7 or 7½ h.p. normal capacity. They have been worked up to 11 h.p., an outrageous overloading. A year ago it was not possible, six months ago, even, to design an electric motor to meet all the exigencies of street car service. There was not that intimate knowledge of street-car service in the possession of electrical engineers to make this possible; and, on the other hand, there was not that knowledge of electrical machinery on the part of street-car builders to enable them to materially assist us in this matter. There had not been in the early state of this work a car properly constructed, properly braced, with its brake apparatus properly made. Two ways of attaching motors to street cars have been developed, both recognising the variation of distances and position of car body or truck and the wheels. One was to place a motor on the car, and to yieldingly connect it to the axle. The other was developed by us, and constitutes one of the particular features of our system. It is to centre the motor upon the driving axle, and to flexibly or yieldingly support the other end from the car body or car truck. This is to allow, of course, the axle to retain its present freedom, and also, when we use a spring, to ease the strain on the gears.

Experience, during the past year, has taught us much in the matter of detail. It is the details that yet remain to be mastered. That is only a question of time. We have already spent 150,000dols. in Richmond, and many thousands in other places. We have on hand some 28 or 29 contracts already. We have several roads in operation now, and will have a large number in operation during the winter. In all of these roads which we are to build, there is not one in the form of an experiment; everyone of the 28 or 29 roads are to be paid for in cash or its equivalent, and are not put in for advertisement. They are not to be put in to be taken out again; but to do hard everyday service, running from 90 to 120 or 125 miles a day, with sometimes as high as 95 or 96 per cent. of the gross working force in use.

So far as the actual cost of operation is concerned, it would vary with the different systems. The actual power expense, the expense in the central station—which includes all depreciation of dynamo machines, engines, all expenses of attendants and of engineers and electricians, the use of oil and waste, and the consumption of coal; in fact, everything in the station will, on a road with a direct system of supply (and it will be about the same thing with a conduit as with the overhead system), not exceed 1½dols. a day for cars making 75, 80, or 90 miles a day. In Richmond a local electric light company supplies the power to the electric railway company at 1dol. 60 cents a day, and they make money. At Harrisburg, with a very much smaller line, with six cars, maximum grades of about 6 per cent., making about 700 or 800 miles per day, they run at a consumption of about 100lb. of coal per hour in their central station, making an average of about 6 h.p. or 7 h.p. per car. In Richmond, the average loads in our central station for the 30 cars in operation is about 5 or 5½ h.p.

There have been a good many objections raised against the overhead system, and one of the most frequently-asserted objections is that of appearance. This objection is largely brought about by careless construction, and it is simply a question of dollars and cents to get rid of it. It is quite possible to construct an overhead system that will be ornamental. Such will doubtless be the case with the Beacon-street road, Boston, which the West End Railroad Company is to build, and which calls for an expenditure five times that of the Richmond road. The road has got to be put up in the best possible manner. We are going to use a wire that has a tensile strength of over 100,000lb. per inch, and we use for our span wires a wire that will practically never break. The trolley wire is of silver bronze. That wire is not liable to come down, and if by any accident a section of it does come down, that goes out of operation and the rest of the road remains in operation. There will be in the Boston station over 400 h.p. of dynamos and steam-engines, and it is our intention to show what is possible on an overhead line on that road. So far as the conduit system is concerned there is no possible question as to its working, having certain abnormal conditions of drainage. The Bentley-Knight people are putting in two to three miles of conduit in Boston, to be in operation this winter, and the street railway people can look to that city this winter for the best possible trial that has ever yet been given to electricity as a motive power. The use of electric railways has been largely confined to milder climates than that of Boston, but our company will have several road in operation in Northern cities during the winter. Twelve cars in Akron, twenty in Cleveland, twenty in Scranton, twenty in Boston, with at least three more heavy cleaning cars. These are all northern cities, and the objection against the trial in Richmond, that it proves nothing about winter (which is not so because they have the worst sleet storms there) will be met by the operation of these Northern roads. These roads will prove more to street-railway people about the practicability of electricity than all the other roads put together. Our present policy is simply to devote our work to the existing contracts on hand. We do not care for any additional work at this time, but wish to devote ourselves to the necessary detail supervision of every element of our work now in hand, which means either the success or failure of electrical railways in the Northern cities; and next spring we propose to know all there is to be known about electricity in the winter; and, of course, next spring we expect to take any contracts that are offered. It seems to me to be the part of wisdom for street railway people generally to see what these people who are putting in the various systems are going to do in the ice and snow.

Mr. Wason, of Cleveland: I would like to ask Mr. Sprague if any of the officers or directors of the companies he has referred to are connected with the Sprague Electric Motor Company.

Mr. Sprague: I am glad to say, in answer to that question, that no man connected with our company directly or indirectly, is interested in the electric railway company at Richmond. The parties who had that road put in did so on a commercial basis, and paid for it. The transaction was wholly of a business character. The Sprague Electric Motor Railway Company is controlled by three persons. One of them is the president of the Edison Electric Light Company, acting entirely in his individual capacity; the other is myself, and the third is one of the most prominent financial men in the United States. Not one of them has had any interest in any electric road which we put in, or expects to have; and we do not want them to have any financial interest in it. We do not care to buy testimonials about our work. We are in a position to know as much as anybody can know about electric propulsion. I think I have about me the best force in the United States to-day. It requires trained men to do the work, and it is, in this new business, difficult to get them. So long as they report to us any defects which may exist, and are faithful and loyal to our interests, we will take care that we will get over any troubles which may develop. We are half over a trouble as soon as we know just what it is. One of the troubles you have on an overhead line is the liability of the line being struck by lightning. There has never been to my knowledge, any lightning device that has been entirely successful in diverting lightning strokes until quite recently. We have now got lightning pretty well harnessed. We have had lightning strike the car when the man was operating it; he simply hears the "click," and sees the spark and that is the end of it. I am perfectly willing to ride on the car in the

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heaviest thunderstorm that was ever known with our latest devices. The lightning cannot get into the station or into the motor except to go where we wish it; it is a trouble of the past, and is now entirely remedied.

Mr. McCREERY, of Pittsburgh: Will Mr. Sprague say how many cars he intends to run in Boston?

Mr. SPRAGUE: The total length of the line will be about twelve miles, two or three miles of conduit put in by the Bentley-Knight Electric Company, the balance, which is about six or seven miles of double and single track, aggregating ten miles of single track, is to be operated by the overhead line; there will be twenty cars, and three cleaning cars run. The central station, which is at a place called Alston, near the middle of the line, is equipped with over 400 h.p. of engines and dynamos. This is in excess of the needs required for the trial; but the president of the West End Street Railway of Boston is one of the most progressive of street-railway presidents; and he is fully confident that electric railway propulsion in some form or another will succeed. The station will be large enough to do the haulage of a good many cars if the road is equipped with electricity, whether if by the conduit, overhead, or storage battery system. He will have a station which can handle all the cars that he will need for the service on that line as easily as it will handle the twenty cars with which the experiment is to be made. When you are putting in a dynamo it is as easy to make arrangements for a 100 h.p. as it is for 10.

Mr. EDWARD J. LAWLESS: On September 12th, I was in the city of Richmond, and I found that the car houses at either end of the road contained twenty-eight out of the forty cars, which is the full complement of the road, and they were evidently idle. I asked what the reason was, and they said that the motor on the cars burned out. We asked what was the cause of it, and were told that there had been twelve days of very rainy weather. I then went to a point where I could see the cars quite a distance both ways as they came along, and I found that they were running from a quarter of an hour to an hour and a-half apart. Now, I should like to ask whether that condition of things occurs often. I should also like to ask what the cost of repairing the motors is after they are burned out, and thus we can get at something practical. I know positively what I assert, that on the day mentioned they were running in the condition mentioned. I do not assert the cars were burned out; I was only told that.

Mr. SPRAGUE: The management of that road has been characterised by the grossest mismanagement. I want to place the responsibility for an accident on electric roads where it belongs. If you have got a cable and some ignorant fellow shoves a spike into it and lays up the system, are you going to blame the cable? And so with the electric railway; if it is run through mud and slush in the street seven inches below the water line, and by so doing the machinery is deranged and the motors are left in the streets uncovered, and not even cleaned in nine months, if anybody is responsible it is the man in charge. No machine will stand this sort of usage. So far as natural and expected depreciation is concerned, this company is amply able and willing to make a reasonable guarantee as to the depreciation on motors where instructions as to their use and care are faithfully and intelligently carried out. They are not to be abused and left in the street and treated as if they were solid iron. To-day there are not less than 38 out of the 40 cars ready for operation. We have now got a good careful man there, and he wrote to me the other day that there is no difficulty whatever in maintaining 29 out of 30 in operation; and out of 40 cars there should be 36 ready for actual operation. I have told you the Richmond machines are overloaded. Nobody knows that better than I do. The machines which are built for 7 h.p. are obliged to operate up to 10 or 12 h.p., and consequently are greatly overloaded. The Richmond motor is only one type of machine to meet one condition of travel. We have now machines whose capacity, working steadily, is 13 h.p. or 14 h.p., and which may be worked up to 18 h.p. or 20 h.p., and will not only carry the ordinary load in Richmond of 12,000lb. or 15,000lb. weight, but will take 20,000lb. or 30,000lb. up a 10 per cent. grade. The new machine is one which can be absolutely and perfectly enclosed, so that it will be water and dust and oil proof. You cannot get water into them, and I believe they will run for a month without oiling. But you cannot yet take an electric machine through 6in. or 8in. of water with no covering without laying it up. So far as depreciation on machines is concerned, ordinary machine practice is to reckon the wear and tear at 10 per cent. a year. I believe I am justified in saying that in the near future the depreciation of an electric machine on a street railway car will be but little more than that of an ordinary steam-engine, with equal care and duty, but we prefer to put the figure a little higher now and be on the safe side. A reasonable amount of care and attention will save nine-tenths of any trouble which will happen on an electric car.

Mr. SINCLAIR, of Galveston: What will it cost?

Mr. SPRAGUE: Ordinarily about 100dols. per h.p.; sometimes as low as 75 or 80, according to the conditions of the proposed plant.

Mr. LAWLESS: I just wished to give the gentleman the result of my investigations, as I have visited several electrical lines for the purpose of seeing what was in them.

Mr. HENDRIE, of Detroit: I would like to ask if it is a common occurrence in Richmond to have 18 men in the repair shops there. I counted that many the day before yesterday.

Mr. SPRAGUE: It ought not to be, but I do not hold myself responsible. If you want to enquire about certain other roads which are properly managed, I shall be glad to refer you to the gentlemen in charge of them.

Mr. LITTLE, of Louisville: What is the cost of repairs to dynamos?

Mr. SPRAGUE: The depreciation on dynamos not over 5 per cent., and on motors it ought not to exceed about 12 per cent. We are willing to guarantee it, provided your men will give that ordinary and proper care to the machines which should be given.

Mr. PRATT, of Worcester: When the armatures are burned out from any cause, what does it cost to renew them?

Mr. SPRAGUE: I do not know that I am justified in answering that question; it is a commercial matter and depends on circumstances. Your bill might be 50dols., more or less, and certainly would be reasonable.

Mr. PRATT: It is commonly stated that it would cost 200dols.

(To be continued.)

BRITISH ASSOCIATION, BATH.*

ON THE CONDUCTION OF ALLOYS AND SOLID SULPHIDES.

BY J. H. GLADSTONE, PH.D., F.R.S., AND WALTER HIBBERT, F.I.C.

The following experiments were instituted in connection with the work of the British Association Committee on Electrolysis. One of the questions originally raised was whether there was any resemblance between the conduction of an alloy and that of an electrolyte; or, to put it in another way, whether the passage of an electric current through an alloy is associated with any separation of its constituents.

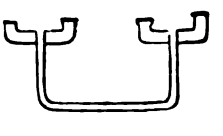
The method adopted by us depends on the assumption that any such separation would produce changes of resistance, the changes being, in all probability, different at one electrode from what they would be at the other.

The apparatus consisted of a U tube of glass of the following dimensions:

Internal diameter, 0·45 centimetres; total length, 28 centimetres; horizontal portion, 11 centimetres; each vertical portion, 8·5 centimetres. The ends of the tube were carefully fitted with corks, so bored as to form large terminal cups, as shown in section in the annexed diagram.

In the middle of the horizontal part of the U a platinum wire was fused through the glass for the purpose of making connection with the central part of the alloy whilst the current was passing through it.

The alloy used was the "fusible alloy," sold by Messrs. Hopkin and Williams, containing bismuth, lead, tin, and a little cadmium. It was chosen because of its low fusing point, which enabled us to keep it perfectly liquid at the temperature of boiling water. A suitable quantity was fused and poured into the U tube, some care being needed to drive out all air bubbles. The tube was then placed in a water oven and kept 100deg. C. Connections were made through the lid of the oven by means of three thick insulated copper wires, two of them going to the cups at the end of the U tube, and the third to a



mercury cup at the bottom of the oven, into which there dipped the platinum wire from the middle of the U. By means of these connections the two halves of the tube were joined to the ends of a metre bridge wire, and the ratio of the resistance of one half to that of the other obtained in the usual way.

In the earlier experiments a slight modification of Carey Foster's arrangement of the bridge was tried, but it was found a little inconvenient for these particular experiments, and was therefore replaced by the ordinary simpler form.

The currents employed varied in different experiments from 5 down to 0·2 amperes, running generally for four or five hours, with two or three tests during that time. On one occasion a current of about 0·4 ampere was continued for twenty-four hours.

The results of the experiments were always negative, no change of resistance being detected which did not fall within the limit of probable error.

It ought to be pointed out that the sources of error were considerably greater than usual. The resistances under comparison were so small, and such great temperature differences existed between the various junctions, that great precautions had to be taken against thermo-electric disturbance. Errors arising from this source were generally eliminated by repeating the observations with a reversed current. In some cases the battery circuit was completed after the index of the galvanometer had come to rest under the action of the thermo-current; but this was not considered so decisive as the other method.

* Communicated by the Secretary of the Electrolysis Committee.

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A few experiments were made by a method depending on the fall of potential in one half of the tube compared with that in the other half, but they yielded the same negative result.

This conclusion is true for nearly all our experiments to one part in 500 and for many of them to one part in 1,000. The conclusion is strengthened by the fact that when small changes did occur they were shown to be due to some influence not dependent on the direction of the current. Thus in one experiment already alluded to, in which the current continued for twenty-four hours, a change of zero amounting to 0·7 of a millimetre was observed. As this was a fairly large change compared with the usual result, the current was reversed for twelve hours. At the end of that time the zero had moved a little further in the *same* direction, showing that the alteration was due to some other cause than the one we were seeking to detect.

One or two data obtained incidentally may be of interest.

The alloy had a specific resistance at 100deg. C. of about 107,000 C.G.S. units—*i.e.*, a cubic centimetre of it had between opposite faces a resistance of ·000107 ohm.

To assure ourselves that changes in composition would effect the resistance two experiments were made. To the alloy in one half of the U tube 0·5 per cent. of lead was added. This was done with some care, but it could hardly be expected that the distribution of the lead would be uniform through the one half and confined to it. However, a fall in the ratio of the resistances of the two limbs of nearly 3 per cent. was noticed. In the second experiment the amount of lead added was 1 per cent., and the fall in resistance of that half of the tube was about 5 per cent.

This negative result is in accordance with that arrived at by Professor Roberts-Austen with other alloys and by a different method.

Solid Sulphides.—It is well known that certain mineral sulphides conduct electricity, and it is evident that if such a compound were placed between two sheets of silver, and an electric current passed through, the condition of the silver would at once reveal whether any sulphur had combined with it on the one side, or any metal had been deposited on the other. Experiments made some years ago gave a negative result, but they have been repeated more carefully recently. The plates of silver were connected with an astatic galvanometer and a battery, and the current varied in different experiments from a very small value up to about 1·5 ampere.

The condition of the sulphide was also varied. Sometimes we used small blocks of native galena, cinnabar, &c., ground smooth on two opposite faces; in other experiments we employed finely-divided powders.

The sulphides generally produced a slight tarnishing of the plates, but it was found that something similar occurred without the current. In the case of three sulphides—lead, mercury, and copper—however, the tarnishing was extremely small compared with what would have occurred if the whole current had passed electrolytically. We concluded, therefore, that there was no electrolytic conduction, or, if any, very little in comparison with the non-electrolytic.

During the course of these experiments it came to our knowledge that Hittorf, in 1851, had experimented on silver sulphide fused into solid cylinders, and showed that the sulphide is electrolysed with the formation of threads of metallic silver. This we confirmed, working with tightly compressed powder; and we observed that the current was at first small, but rose gradually, and then jumped to a much greater value, no doubt at the moment when the space between the poles was bridged over by the metallic threads. Under the microscope the reduced silver seemed to be fused. Hittorf observed a similar decomposition of cuprous sulphide.

The following are the additional results we have arrived:

Lead Sulphide.—This compound, whether in the form of powdered galena or the precipitated sulphide, conducts pretty easily. It always gave a slight indication of polarisation after the current had passed through, but so slight that it might have been due to impurity. The conduction was almost entirely non-electrolytic.

Copper Sulphide, CuS.—This compound also, whether fused and powdered or obtained as a precipitate, conducts readily enough. When silver electrodes were used no polarisation could be detected. With platinum electrodes very little. The silver plates remained bright when the fused sulphide was employed; with the precipitated substance they were both marked.

Iron Sulphide.—Natural iron pyrites gave no polarisation or discolourisation of the silver electrodes. An artificially-prepared fused compound gave a little polarisation, but its composition varies.

Bismuth Sulphide.—Conducts very little. No polarisation was obtained.

Mercury Sulphide (cinnabar).—Same results.

Potassium Sulphydrate.—Dried at a red heat, this was found to be a non-conductor. The same appears to be true of the *sulphides of calcium and barium.*

It appeared, therefore, that solid sulphides divide themselves into two classes: those which are electrolysed, and those which conduct with little or no decomposition. Now it happens that the two sulphides which are easily electrolysed—namely, the silver and cuprous sulphides—are of analogous constitution, Ag_2S, and Cu_2S, and differ in that respect from the others. It occurred to us that the thallium sulphide, Tl_2S, might be like them. Mr. Crookes kindly gave us some small bars of this compound, saying at the same that he had found its power of conducting electricity to be very rapidly augmented on heating. We found that it rapidly increased in conductivity to about 105deg., about which temperature it also softened, and the conduction was accompanied by considerable electrolysis. We dissolved up this specimen and estimated the thallium and sulphur. The results showed tnat it contained much more sulphur than the compound Tl_2S. It was probably a mixture of that body with the compound Tl_2S_3, which is said to be soft even at a summer temperature.

We therefore prepared a specimen of the thallious sulphide, Tl_2S, ourselves, and, after carefully drying it at 125deg. in a current of carbonic acid, found it on analysis to be nearly pure Tl_2S. This compound was not melted even at a temperature of 290deg.—300deg. C. It shows a small conduction at ordinary temperatures, and up to 100deg., after which it increases slowly to about 170deg. Beyond this the increase is more rapid.

Throughout the greater part of this range of temperature—that is, from 50deg. upwards—there was evidence of polarisation, the value of which increased very rapidly, as the temperature rose from 100deg. to 130deg. Measurements were made by the potentiometer method, the highest value obtained being very nearly 0·3 volt.

The results, therefore, in this case agree with our anticipation that solid sulphides similar in constitution to the silver and cuprous sulphides are capable of being electrolysed; while solid sulphides of the type MS conduct with little or no decomposition.

ON A SYSTEM OF ELECTRICAL DISTRIBUTION.*

BY HENRY EDMUNDS, MEMBER.

It has been remarked that it is undesirable to bring a paper of this kind before a scientific society on a subject which is only in its initial or untried stage. While there may be some justice in this remark, I think that in bringing this paper before the society to-night, I may have the opportunity of laying before you the results of certain experiments, and actual work now extending over some 10 or 12 months, and of pointing out to you what have been the results of that work, and what the indications are with regard to its usefulness and extension.

In designing this system of central station lighting it has been my endeavour to develop a plan of effectively and economically distributing the electric light over a given area, which should practically isolate each installation, and make it independent and self-contained; which should obviate the use of objectionable machinery on the consumer's premises, which should ensure freedom from powerful and dangerous currents of electricity, which should provide a reliable supply of the electric current at all hours of the day or night; and which would enable a simple and readily understood form of meter to be used that would command the confidence of the consumer.

One of the great desiderata of a system of lighting is constant supply. It is not sufficient to supply the illuminant for a specified number of hours per day. What the householder wishes to have is a means by which he has always at hand a reliable source of light, capable of supplying all his requirements night and day. To ensure this, it would be necessary either to have the generating machinery always at work during the whole 24 hours, or to employ some system of storage. Even if the machinery were constantly kept running, however, that would not render the constancy of the supply absolutely reliable, for the machinery might break down owing to accident or wear, and the district deprived of light until the necessary repairs were made. Therefore, it is essential that a reserve of electricity, independent of the generating plant, should be at hand, and such a reserve can only be obtained by the use of storage batteries.

The subject of electric lighting in conjunction with storage batteries is one that is receiving considerable attention from a good many engineers at the present time. The desirability of working with them has, I think, been admitted by most engineers for a long period; but the difficulty in connection with their use has been great. Among other things, the durability and efficiency of the battery itself has been more or less an unknown quantity, and this has caused people to hesitate before embarking upon any large amount of work dependent on them. It is hardly my province now to go into the history of the several methods which have been tried, but we may simply look on the two broad modes of working—viz., charging batteries in multiple, or charging them in series. As we do not, in this system, propose to charge in multiple, we can leave that out of the question. We may therefore consider the mode that we are here adopting of charging batteries in series. It has been found to be more economical to use comparatively small conductors with suitable current, and high E.M.F. enabling one to carry the current over long distances from central stations, and to supply the current at different points on the line, as may be required for local work or use.

An opportunity for distributing current over a large area was presented to me some months ago, where a central station was available, suitable as to its position and size, but a long way from where it was intended to supply the bulk of their current for lighting purposes. It was necessary for them to consider the respective advantages of direct supply with low tension, and high tension in conjunction with transformers. The former was out of the question on account of the distance; and the latter was at that time in disfavour, owing to several breakdowns and interruptions of the light to consumers having been reported in London. It was therefore deemed desirable to work in conjunction with a reserve, such as storage batteries in some form or other, and the idea occurred to me that a system might be developed which would practically be analogous to the transformer system, but using direct in lieu of alternating currents, and charging batteries in series with a constant current on one main line rather than in parallel, and simply increasing the E.M.F. as the work increased and as the length of the line extended. This might be done in several ways, by dividing the line into sections, charging each portion for a good number of hours, according to the probable demand, or by an arrangement for supplying current from the main to a portion of any group of cells less than the whole; but here a difficulty occurs, for it is most undesirable to be charging batteries as a whole or in part

* Abstract of paper read before the Society of Telegraph-Engineers and Electricians on Thursday, November 22, 1888.

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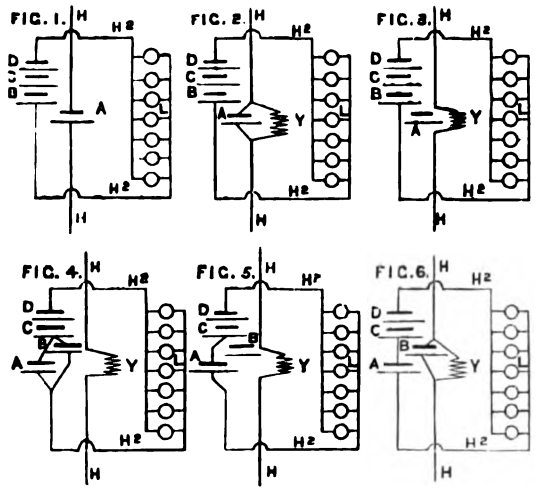
at the same time that they might be wanted for discharging. To obviate this, the batteries might be duplicated, so that one portion might be in the charging main and the other in the local. But this, again, is limited by the number charged in series at the same time. Besides this, the cells that have been charged have a large difference of potential, when brought into the local, which causes a fluctuation of the lights when such changes occur.

This brings us to the system which I have devised. Sets of accumulators are placed in groups at various points, or sub-stations throughout the district to be lighted, and charged in sections from the central station. The secondary batteries at each sub station are divided into four equal groups, with any convenient number in each group. For instance, we may have four sets of eight cells each, of which three sets, or 24 cells, will always be in connection with the lamp circuit, and supplying current locally to those houses which are in connection with the sub-station; while the fourth section will be in the main circuit, in series with the other sub-stations, being charged by the current from the central station. At short intervals, the charged group is switched out of the main circuit into the supply, its place being taken by one of the discharged groups. In order that the three groups in the supply circuit shall be as far as possible in an equal state of charge, it is essential that the changes should take place at frequent intervals, otherwise one group would become highly charged, while the other three are being nearly exhausted. Therefore, I have designed an apparatus by which each group is brought in succession into the charging circuit, charged for a short period—two minutes in actual practice, and then removed again into the supply circuit, in order that it may discharge itself. This apparatus I call a distributor.

The operation of the distributor may be understood from this diagram. You will see that the four groups of cells are lettered A, B, C and D. H H is the main charging conductor, H 2, H 2, the branch conductor, and L the local installation ; Y, a resistance.



In Fig. 1, the battery, A, is shown in the main conductor, being charged, while batteries B, C, and D are connected together in series, discharging locally.

In Fig. 2, the resistance, Y, is connected in parallel with the battery, A, thus giving a by-path for the main current, which now divides itself between the two circuits,—viz., the resistance and the battery.

In Fig. 3 the battery, A, is now disconnected from the charging main, the resistance, Y, carrying the whole of the current, and maintaining the continuity of the charging circuit. You will observe that battery A is now free, and is to be removed to the local circuit.

In Fig. 4 this is effected by coupling it in parallel with battery B. You will observe here that the two negative poles of batteries A and B are coupled together to the local negative, while their positives are coupled together to the negative of local C. We have thus been enabled to introduce A into the local circuit without causing any alteration in the E.M.F. of the series, or consequent fluctuations in the local circuit.

We can now, as in Fig. 5, isolate the battery B from the local battery A having taken its place, maintaining the continuity of the local.

Battery B is now connected with the main, in parallel with resistance Y, as in Fig. 6. Resistance, Y, is then cut out, leaving battery B to receive the full charging current of the main, H H—it practically being the substitute for battery A, as in Fig. 1.

These cyles of changes are essential to the efficient carrying out of this system, for we must guard against interrupting the main charging circuit because of other work going on in the circuit at the time in series with the battery under consideration. We must also be careful at no time to alter or fluctuate the pressure of the local batteries. We must also at no time have the charging main in contact with the local batteries, as this might cause a variation in their pressure, or in an extended system have a tendency to leaking through the local to earth, with its attendant dangers. You will see, therefore, that by carrying out this cycle we ensure all the requisite conditions.

In practice, this cycle of changes takes place at intervals of about every two minutes. The batteries A, B, C, and D, receiving their increments of charge. A for two minutes, B for two minutes, C the same, and D the same ; so that in eight minutes each of the cells will have received two minutes' charge. The charge now proceeds in the reverse direction—from D to A. Thus the cycle is A B C D, D C B A, etc.

Although the process of describing in detail the changes which are shown in the diagrams, and which complete one cycle, have been somewhat lengthy, it must not be supposed that the actual change in the mechanical-electrical actions of the distributor which bring about this result are of any protracted period of time. If so, the value of the system would be neutralised. The actual time occupied is less than one second, so that in 24 hours the distributor instrument is only actually under movement for 12 minutes. This practually consumes very little time, and prevents any appreciable wear of the moving parts.

But it will be observed that in 24 hours we only charge a group of cells, as a whole, with a six hours' current. On the other hand, we only want one-third of the charging potential in the main. This enables us to do a given amount of work with one-third of the plant, and one-third of the pressure at the charging station, compared with what would be required if we were doing the same amount of work by a direct system. This is very important. The cells are kept in much better condition by continually receiving fresh increments of charge, and having periods of rest from discharge. Also, the loss due to difference of potential between the charging and discharging current is minimised, it being found in practice that we can continue charging the cell to its maximum capacity with a mean voltage of 2·25 instead of 2·5 per cell, as is required where cells are charged continuously. This, on a large scale, is a considerable element of economy when there are a large number of cells in the charging main. Besides this we find that an approximately constant potential on the local circuit enables us to run lamps at a higher efficiency, without the risk of rupture due to sudden rise of pressure, and, so far as we can judge, the life of the batteries is considerably lengthened by this mode of intermittent charge and rest.

It is obvious that running a smaller station during the whole 24 hours is much more economical than running a large station only for a few hours during such time as the current is consumed. The current, being always constant in volume, enables a single main of one size to be used, preventing complications, and only requiring an increase of pressure as the work extends, which pressure, however, as has been pointed out, is only one-third of the sum of the pressures of the work done on the local circuits. For example, suppose batteries were used in 100 centres, with an average of 50 volts each, giving the sum of 5,000 volts altogether, it would require at a central station to charge those altogether in series a potential of over 6,250 volts, exclusive of the line, while by this mode of charging we can effect the same results with a charging potential not exceeding 2,000 volts, exclusive of the line. The safety ensured through this is of the highest importance, both in removing high pressures at the central station and through differences of potential between the earth and the line at various points ; considerably cheapening the cost of insulating the main conductors, and freeing the system from danger of leakage to earth, with its attendant dangers ; enabling a lower grade of insulation to be used for interior wiring ; and getting rid of that vexed question which all contractors are feeling with regard to complying with the requirements of the insurance offices. This is a considerable factor of economy in extended work, and is much more important than at first sight appears. Many people are objecting to the introduction of electric lighting more out of consideration to the first cost of installation, which is now enhanced by the many difficulties experienced in complying with the conditions of safety, where extremely high tension currents are used, than on account of the cost of the current as a matter of consumption.

The current supplied from the dynamos at the central station is 70 amperes, this being the amount by which the large-sized E.P.S. cells are best charged. The voltage of the dynamo varies according to the work at any one time on the line, and the current is maintained constant at all times. A simple mode of ensuring these results has been obtained by using an ordinary series dynamo, whose field is excited from a separate source, by batteries, for example, incidentally charged from the main, and the speed of the dynamo is varied in accordance with the variations of the work or external resistance of the circuit. I find that by proportioning the size of the engine to the dynamo it has to operate, we need only keep a constant pressure on our engine to ensure the regulation being entirely automatic. We have been able to dispense with electric regulators of all kinds in the station, for the dynamo practically regulates the speed of the engine, only going at a given speed in order to produce the requisite E.M.F. to supply the 70 ampere current through the whole of the work in circuit at any time. Should batteries be cut out of circuit, the result is that the resistance is lessened, upon which the volume of current is increased. This immediately acts like a brake on the engine, causing it to run at a less speed until it has accommodated its speed to the mormal 70 amperes, provided that meanwhile the steam pressure in the cylinder has been kept constant. This can conveniently be done by means of an ordinary steam pressure regulator. Should, however, more work be included in the circuit, the result will be that the current will suddenly fall, freeing the breaking effect of the engine, causing it to respond and run at a higher speed, until such time as it has brought up the current to the normal of 70—of course demanding more steam, which the stoker must look out for. In this way it is only necessary, by means of a speed counter, to take the revolutions of the engine or dynamo of the station at any time as being an exact index of the work going on at that time, and, as the work increases when the speed of any one engine gets up to its mechanical limit of safety, two or more machines are then brought in series with the others, and, acting in the manner already described, keep this constant current with its proper potential always on the main circuit. Having a time apparatus to effect the changes described in the battery, and a constant current in the main, it is only necessary to bring these two together, as the tension on the batteries is practically the same, in order to form a very efficient and simple motor, which, having only to deal with the current supplied in the charging, has not to differentiate and take account of the various amounts used in the discharge.

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Of course it may be said that a system of this kind is essentially dependent on the mechanical details used for carrying the same into effect, and here actual practice has been of very great use to me. The Cadogan Electric Light Company of Chelsea having adopted this system, has enabled me to see actually what such short-comings were. The apparatus I have here to-night is of the kind that has been in use there, and, like all first forms, has not performed as well in practice as it did with the care and attention it received in the laboratory.

The apparatus here consists of a powerful electro-magnet, driving a set of cams, which operate four levers, each lever carrying a full set of combination of contacts for each of the groups of batteries in use at one time. This reciprocating lever arrangement, however, has shown a serious difficulty, for the levers have occasionally wedged themselves so tightly that the electro-magnet could not draw them out, or, on the other hand, have proved too slack, so that insufficient contact was made, and sparking and heating caused in the apparatus. All this, I am glad to say, has been got over by the substitution of a rotary for a reciprocal motion, and now I can show you an improved form of apparatus which is doing the work here this evening, which carries out all the requirements of this system in a much simpler manner. When any group of cells are sufficiently charged so that they ought to be disconnected from the charging main, an arrangement called a voltage regulator is brought into use. This causes the batteries to be disconnected from the main, and to remain disconnected until such time as they are discharged sufficiently to reduce their E.M.F. to a lower level, when the apparatus automatically causes the battery to be again put into the charging main. It will be obvious that such a system as this is sufficiently elastic, by varying the number of cells, to give practically any potential that may be demanded, and can therefore comply with all kinds of requirements for lighting, arc or incandescence, or supplying current for other purposes. It is very desirable not to have too great a variety of pressures, and, therefore, in houses where but a small amount is demanded, it is best to put down a plant of sufficient size to supply several together from one distributor, thus forming a small station, it being, however, always desirable to have the same as near as possible to the point of consumption, and much cheaper to carry our charging main there than to have the local discharge mains. It is convenient not to have such stations too large, or at too great a distance from their work. For suburban or scattered lighting, this system is very useful, as only one main is required of, say, ¾in. cross-section, which can be conveniently carried overhead or underground.

In this paper I have not gone into the question of cost, but from the experience we have had think that such a system compares most favourably in this respect with any of the direct or alternating current methods, and I hope it will prove a means of supplying that great demand which all engineers feel is now upon us.

NEW COMPANIES REGISTERED.

The Douglas Patent Clock and Electric Meter Company, Limited.—Registered by Waterlow Brothers and Layton, Limited, with a capital of £10,000 in shares of £10 each. Object to purchase or otherwise acquire and undertake the business of manufacturers of the patent detached pendulum and other clocks, and of meters for the measurement of electric currents, now carried on at 93, Vyse-street, Birmingham, under the firm of the Douglas Patent Clock Company, and to acquire all and every of the assets and liabilities of the said firm in relation to the said business, and with a view thereto to adopt and carry into effect, with or without modification, an agreement dated October 25, 1888, and made between William Henry Douglas, Edwin Lewis Gyde, and George William Whitehouse of the one part, and John William Wall, on his own behalf, and as trustee for the Company, on the other part; to carry on business as manufacturers and factors of the said annual clock and electric meter, and any business of a like or kindred character to that now carried on by the Douglas Patent Clock Company. The first subscribers are :

	Shares.
W. H. Douglas, High-street, Stourbridge	30
E. L. Gyde, Soho-hill, Handsworth, Birmingham	30
G. W. Whitehouse, Hylton-street, Birmingham	30
T. Parker, Newbridge, Wolverhampton	30
J. Moseley, Cringle Hall, Levenshulme, Manchester	30
H. P. Holt, The Cedars, Dewsbury	30
S. W. Page, The Poplars, Penn Fields, Wolverhampton.	1

The first Directors shall be Thomas Parker, Edwin Lewis Gyde, George William Whitehouse, and William Henry Douglas. The qualification of every Director shall be the holding of 30 shares in the capital of the Company. The remuneration of Directors shall be determined in general meeting. William Henry Douglas shall be the first managing director of the Company.

ELECTRO-HARMONIC SOCIETY.

The next meeting of the Electro-Harmonic Society Amateur Concert is to be a Ladies' Night, and will take place at the St. James's Hall Restaurant (Banquet Room), Friday, November 30th, 1888. Artistes: Mrs. A. Siemens, Mrs. Theobald, Miss Spagnoletti, Miss Mary Doughty, Mr. Geo. Clues, Mr. T. H. Harrison. Violins: Miss Edith Doughty, Mr. T. E. Gatehouse. Violoncello: Mr. W. Stepney Rawson. At the Pianoforte: Mrs. J. Elvin, Miss Rawson, Miss Margaret Doughty, Mr. Alex. Siemens, Mr. Alfred Izard. Recitations by the Rev. Geo. Bell Doughty. Musical Directors: Mr. T. E. Gatehouse and Mr. Arthur Thompson. A Broadwood piano will be used. To commence at 8 o'clock. The following is the programme :

PART I.

Piano Duet ..... "Wedding Music" ..... Adolph Jensen
Mrs. J. Elvin and Mr. Alfred Izard.

Ballad ..... "Speed on my bark" ..... Henry Leslie
Mr. T. H. Harrison.

Chant Religieux ..... "Ave Maria" ..... Gounod
Mrs. Theobald.
(Violin Obligato, Mr. T. E. Gatehouse).

Recitation ..... "The Revenge" (A Ballad of the Fleet) ..... Tennyson
The Rev. Geo. Bell Doughty.

Piano and Violoncello. "Allegretto, from Sonata, Op. 39" .. Rubinstein
Miss Rawson and Mr. W. Stepney Rawson.

Song ..... "The Three Fishers" ..... John Hullah
Mrs. A. Siemens.

Violin Duet ..... "Schiummerlied" ..... C. Ersfeld
Miss Edith Doughty and Mr. T. E. Gatehouse.

Song ..... "Good-bye" ..... Tosti
Mr. George Clues.

Song ..... "Leaving, yet loving" ..... Th. Marzials
Miss Mary Doughty.

PART II.

Pianoforte Duet ..... "Waltz" ..... Moszkowski
Mrs. J. Elvin and Mr. Alfred Izard.

Rec. and Aria ..... "Giunse alfin il momento" ..... Mozart
Deh vieni non Tardar. (Le Nozze di Figaro.)
Miss Spagnoletti.

Violin Solo ..... "Nocturne" ..... Chopin
Transcribed by Wilhelmj.
Mr. T. E. Gatehouse.

Song ..... "Gipsy John" ..... Frederick Clay
Mr. T. H. Harrison.

Song ..... "My Dearest Heart" ..... Arthur Sullivan
Mrs. Theobald.

Recitation. "How they brought the good news from Ghent" .. Browning
The Rev. Geo. Bell Doughty.

Song ..... "Wie bist du Meine Königin" ..... Joh. Brahms
Mrs. A. Siemens.

Song ..... "Queen of the Earth" ..... Pinsuti
Mr. George Clues.

Piano and Violin Duet ..... "La Favorite" ..... De Beriot and Osborne
Mrs. J. Elvin and Mr. T. E. Gatehouse.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the past week amounted to £5,456.

United Telephone Company, Limited.—This Company notify that dividend warrants will be sent out on the 7th proximo for an interim distribution of 5s. per share.

Notice of Removal.—The offices of the West African Telegraph Company, Limited, have been removed from 98, Cannon-street, E.C., to Winchester House, 50, Old Broad-street, E.C.

West India and Panama Telegraph Company.—The receipts of this Company for the half-month ended November 15 show a decrease of £311, as compared with the corresponding period.

Western and Brazilian Telegraph Company.—The traffic receipts for the week ended October 16, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Company, were £4,495.

PROVISIONAL PATENTS, 1888.

NOVEMBER 9.

16,249. **An improved "bar" or "bridge" electric-light switch.** Andreas Peter Lundberg, 18, Fulham-place, Paddington, W.

16,256. **Improvements in electric meters or apparatus for measuring electricity.** Leslie Bradley Miller, 46, Lincoln's-inn-fields, London, W.C.

16,257. **Improvements in arc lamps.** Charles Eugen Lancelot Brown, 46, Lincoln's-inn-fields, London, W.C.

NOVEMBER 10.

16,289. **Improvements in apparatus for gas and electric meters.** Stuart Bunting, 183, Great Brunswick-street, Dublin.

16,298. **Improved tramcar, omnibus, or other wheeled vehicle, with method of carrying and applying stored electricity for the propulsion of such.** Thomas Pease, 6, Brompton-avenue, Sefton Park, Liverpool.

16,302. **An improved arrangement in construction of primary batteries, by which "abnormal" voltage per cell is obtained.** Carl Anton Johannes, Hugo Schroeder, and Heinrich Eugen Richard Schroeder, 17, Althorpe-road, Upper Tooting, London, S.W.

16,303. **Electric locking mechanism for safes and for other purposes.** Louis Huebner and Rudulph Busse, 433, Strand, London.

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NOVEMBER 12.

16,343. **Improvements in incandescent lamps.** Frank Stanley Willoughby and Frederick Charles Lynde, 25, Cross-street, Manchester.

NOVEMBER 13.

16,438. **Electric register for taking speed of ships.** Henry Wilson, 16, Claremont-terrace, Cleaver-road, London, E.

16,471. **Improved means or apparatus for reversing and regulating the brushes of dynamo electric machines partly applicable to electric motors.** John Smith Raworth, 46, Lincoln's-inn-fields, London, W.C.

16,478. **An improved device for use in establishing electrical communication.** George Frederick Redfern, 4, South-street, Finsbury, Middlesex. (Denis Stanislas Boivin and René Auguste Gouamier, France.)

16,479. **Improvements in storage or secondary batteries.** Henry Harris Lake, 45, Southampton-buildings, London. (Hugo Walter, United States.)

16,481. **Improvements in the mounting of diaphragms of graphophones, telephones, and the like.** James Yate Johnson, 47, Lincoln's-inn-fields, Middlesex. (The Volta Graphophone Co., United States.) (Complete specification.)

16,484. **Improvements in ungumming and bleaching by electrolysis flax, hemp, cotton, and similar exogenous plants.** Emile Marie Hippolyte Andreoli, 62, Loughborough-park, Brixton, S.W., Surrey. (Complete specification.)

NOVEMBER 14.

16,570. **Improvements in electric lamps.** Henri Pieper, Fils, 109-110, Gneisenau-strasse, Berlin.

NOVEMBER 15.

16,603. **An improved automatic electric signalling apparatus for railways.** Edmund Kelly Irwin, 66B, Cottage grove, Stockwell, London.

16,625. **Improvements in electric arc lamps.** Edward William Anderson, 24, Southampton-buildings, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

NOVEMBER 18, 1887.

15,878A. **New or improved apparatus for measuring the time during which a current of electricity or other fluid is flowing.** Victor Popp, 46, Lincoln's-inn-fields, London. Note.—This application having been originally included in No. 15,878, dated 18th November, 1887, takes, under Patents Rule 23, that date.

DECEMBER 20, 1887.

17,502. **Improvements in electricity meters, parts of which improvements are applicable to dynamo-electric generators and motors.** George Hookham, 7 and 8, New Bartholomew-street, Birmingham.

JANUARY 7, 1888.

296. **Improvements in switches for electric circuits.** Thomas Parker, of the firm of Elwell-Parker, Limited, 70, Market-street, Manchester.

FEBRUARY 2, 1888.

1557. **Improvements in duplex telegraphy.** Frank Jacob, 28, Southampton-buildings, Chancery-lane, London, W.C.

MARCH 27, 1888.

4673A. **Improvements in and relating to switch and cut-out apparatus for incandescent electric lamps.** Philip Middleton Justice, 55 and 56, Chancery-lane, Middlesex. (Charles Heisler, United States.) Note.—This application having been originally included in No. 4,673, dated 27th March, 1888, takes under Patents Rule 23, that date.

AUGUST 21, 1888.

12,063. **Improvements in or relating to electrical type-writers capable of being used as printing telegraphs.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.)

12,064. **Improvements in or relating to electrical type-writers capable of being used as printing telegraphs.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.)

12,065. **Improvements in or relating to electrical type-writers capable of being used as printing telegraphs.** Alfred Julius Boult, 323, High Holborn, Middlesex. (James Francis McLaughlin, United States.)

OCTOBER 9, 1888.

14,492. **Improvements in electrical signalling, indicating, or registering apparatus for railway purposes.** John Bruce Sutherland, 45, Southampton-buildings, London.

OCTOBER 12, 1888.

14,691. **Improvements in central-station apparatus.** Theodore Newton Vail and John Ashby Seely, 321, High Holborn, W.C. (Date applied for under Section 103 of the Patents, &c., Act, 1883, 20th April, 1888.)

SPECIFICATIONS PUBLISHED.

1882.

3576. **Distributing, &c., electricity.** J. Hopkinson. (Second edition.) 8d.

1887.

14,445. **Insulating submarine telegraph cables, &c.** R. Haddan. (Prillwitz.) 4d.

14,461. **Electric accumulators.** A. Stetson. 8d.

14,729. **Meter for electrical currents.** W. H. Douglas. 11d.

14,834. **Regulating steam engines, &c., working electric generators.** W. R. Lake. (Menges.) 8d.

15,118. **Electric incandescent lamps.** W. Clarke and C. A. Parsons. 8d.

15,922. **Spring jack for telephonic, &c., purposes.** A. Coleman and others. 8d.

16,217. **Automatically conveying and delivering letters and small parcels by electricity.** F. C. Allsop. 8d.

16,378. **Autographic telegraph systems.** H. J. Allison. (The Writing Telegraph Company.) 8d.

16,863. **Secondary batteries.** F. King. 11d.

1888.

12,986. **Electric sponge.** R. Creswell. 6d.

13,192. **Bleaching by electrolysis.** E. M. H. Andreoli. 6d.

13,341. **Gas batteries.** P. Scharf. 11d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	99½
12 Feb.	1/2	Anglo-American Brush E.L.	4	4¼
12 Feb.	2/0	— fully paid	5	5
26 Oct.	7/6	Anglo-American	100	46½
26 Oct.	15/0	— Pref.	100	78⅛
12 Feb., 85	5/0	— Def.	100	17½
28 June	3/0	Brazilian Submarine	10	13½
14 June	1/0	Con Telephone & Main	1	1 1/16
10 Aug.	9/0	Cuba	10	14
10 Aug.	10/0	— 10% Pref.	10	18½
12 Oct.	2/0	Direct Spanish	5	4
12 Oct.	5/0	— 10% Pref.	5	10½
26 Oct.	2/0	Direct United States	20	9 1/16
12 Oct.	2/6	Eastern	10	12⅜
12 Oct.	3/0	— 6% Pref.	10	14⅞
1 Aug.	5%	— 5%, 1899	100	110
26 Oct.	4%	— 4% Deb. Stock	100	106¼
12 Oct.	2/6	Eastern Extension, Australasia & China	10	13¼
1 Aug.	6%	— 6% Deb., 1891	100	104½
2 July	5%	— 5% Deb., 1900	100	104
2 Nov.	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	105
28 Mar.	8/3	German Union	10	9
12 Oct.	1/0	Globe Telegraph Trust	10	7 1/16
12 Oct.	3/0	— 6% Pref.	10	14⅜
30 April	5/0	Great Northern	10	14½
1 March	5%	Gt. Northern 5% Deb., '83.	100	103½
27 July	10/0	India Rubber, G. P. & Tel.	10	17 3/16
26 Oct.	12/6	Indo-European	25	39½
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	1/16
26 April	4/0	Reuter's	8	8
		Swan United	3½	2⅝
10 Aug.	13½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	39⅞
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	14⅛
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	98½
12 July	4/0	West Coast of America	10	9¼
30 June	8%	— 8% Debs.	100	115
26 Oct.	6/0	Western and Brazilian	15	14⅛
26 Oct.	6/	— Preferred	7½	7⅛
11 May	2/1½	— Deferred	7½	7¼
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	2⅛
30 May	10/0	— 6% 1st Pref.	10	12⅝
13 May, '80		— 6% 2nd Pref.	10	12
2 Nov.	7%	West Union of U.S.	$1,000	122
1 Mar.	6%	— 6% Sterling	100	104

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NOTES.

Galway.—An electric light company is about to start in Galway.

St. Olave's.—Upon the recommendation of their committee, St. Olave's objects to the proposed license of the London Electric Supply Corporation.

Low-Tension Transformers.—The usual type of Westinghouse transformers are from 1,000 to 50 volts, not 2,000 to 100, as usual in this country.

Electric Tram Locomotives.—It is understood that 70 electric locomotives will be eventually required on the Birmingham tramways, which will supersede all steam-cars used on this line.

Newington.—A letter has been received by the Local Board from the House-to-House Electric Lighting Company, stating that they intended to apply for powers to supply their system of lighting in the parish.

Students' Meeting.—The Society of Telegraph-Engineers' Students' meeting will take place on December 6, at 8 p.m., when a paper will be read on "Electric Light Measurements," by Messrs. A. H. Bate and Gimingham.

Telephone Companies.—England and Scotland are now more or less covered with telephone wires. An amalgamation of telephone interests has been spoken of by the chairmen of the leading companies as in contemplation.

The Lighthouse Bell.—At the inshore inlet at Chicago is a lighthouse with a huge warning bell. The hammer for this is actuated by a cam, and a small $\frac{1}{8}$ h.p. electromotor has just been put in to revolve this and ring the lighthouse bell.

The Globe Electrical Company.—We are informed that the Globe Electrical and Engineering Company have removed their stores and laboratory department to larger and more convenient premises, situated at Nos. 2, 4, 6 and 8, Carteret-street, Westminster.

Traction Work.—A very considerable amount of traction work is either being carried out or arranged for in different parts. Several tramway companies are in active preparation for trying electricity, generally on the accumulator system. Plant for electric cars has lately been sent to Lisbon.

Electric Fittings.—Considerable activity is manifesting itself at Birmingham in electric light fittings; many of the gasfitting manufacturers are turning their attention to this branch. If lights at the rate of 100,000 a year or so are being installed, there is evidently plenty of room for increased activity.

Electric Collapsing Register.—A company has just been brought out whose speciality is an electric turnstile register for public places, which will collapse in case a cry of "Fire" is raised. A financial contemporary called this the Thoughtful Turnstile. Perhaps the company is also a collapsing one.

People's Palace.—A conversazione was held last Saturday at the People's Palace, and a second one is to be held next Saturday. The departments of the new technical schools lately built by the Drapers' Company were on exhibition, and experiments were performed by the boys in the chemical and electrical laboratories.

The Lever System.—The directors of Messrs. John Barker and Sons, Limited, Oldham, after inspecting the "Lever" system of electric lighting at the works of Messrs. G. Richards and Co., Limited, Broadheath, have decided to light their new works and foundry by the same system, and have given the order to Mr. Charles Lever, of Bowdon.

The "Helios" System.—The "Helios" Company of Ehrenfeld have built a large welding apparatus for their own use. We also notice that this company are now making an horizontal engine, with a dynamo attached at one side on the same bedplate. The armature of the dynamo is counterbalanced by the flywheel on the opposite side of the shaft.

Electric Fishing.—The incandescent lamp seems a greater marvel to the fisherman than Saadi's diamond in the "Arabian Nights." A single lamp in a fishing-net, at some recent experiments, drew crowds of fish, while a dark net near it was empty. On reversing the arrangement the second net became full; on supplying both with a lamp both nets were nigh like to break.

Railway Stations.—Eastbourne Station, complains a writer to the local paper, is miserably lighted. Semi-darkness prevails, the lamps being not much better than the feudal oil-lamps. Why not put in the electric light to remedy this "glaring" defect? asks the complainant, as a lady visitor at his house who went to meet her husband was unable to find him in the obscurity and gloom.

The Bell Patent.—In some of the cities in the West of America, the city authorities, it appears, fixed the minimum charge for the telephone. The rate was low, and the Bell Company refused to carry on an exchange. Thereupon the Cushman Company introduced their system, but the courts have adjudged that the refusal of the Bell Company does not warrant the violation of their patent by Cushman.

Raising and Lowering.—In the article on coal-gas in the *Encyclopædia Britannica* is said that until electric light can be raised and lowered equally with gas lights the disuse of gas is still out of sight. We should be interested to hear if contractors find any great demand for this, at any rate after the light has been some time in use. We do not think that this point has much influence on the general householder.

By Long-Distance Telephone.—The telegraph was largely supplemented in the recent American elections by the sending of messages "by long-distance telephone," and it is now a common thing to see public notices so headed. Main telephone lines are rapidly spreading over England, and when London is connected to the main trunk lines, we may expect to see our news at breakfast in the daily papers "by telephone."

E.P.S. Smoking Concert.—Last Wednesday a very jovial evening was spent by the workmen of the Electrical Power Storage Company at a smoking concert got up in aid of the E.P.S. Cricket Club, held at the Eastern Hotel, Limehouse. Over 100 were present, and under the kindly presidentship of Sir Daniel Cooper, chairman of the company, the Storage men let loose their energy in songs, music, and general good-fellowship.

A New Application.—Details of new uses for the electric motor come in apace, but the newest application is from Boston, U.S., where a 1 h.p. Sprague motor is used

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to drive an apparatus for massage treatment. Instead of thumping the patient himself, the operator now simply guides the machine, to which electricity supplies the power. The application is believed to be original, and it evidently opens a large field, not only for massage, but even for practice in boxing.

The Brush Corporation.—A gold medal has been awarded to the Brush Corporation for their electric fountain display at Barcelona, and a diploma of honour for electric lighting at Brussels. The corporation has just secured an important order from the Pacific Steamship Company for several of their combined plants for ship use. The important contract for Glasgow Exhibition has just been completed to the entire satisfaction of the executive committee of the exhibition.

Extraordinary Effect of Coupling Dynamos.—We note in *L'Electricien* some particulars of an installation at Teplitz, which seem to us worthy of remark. It seems that, according to this account, there are two dynamos "each capable of feeding 300 incandescent lamps; the two together give 700 lamps of 16 c.p., and 13 arc lamps of 100 c.p." We should advise the engineer in charge to run these dynamos as often as possible coupled in this way—it seems to us economical.

People's Lectures.—The third of a series of three lectures will be delivered by Mr. W. Lant Carpenter at the Town Hall, Poplar, on Wednesday, Dec. 5, at 8, on "Electricity in the Service of Man." These lectures are delivered under the auspices of the London Society for the Extension of University Teaching and the Gilchrist Trustees. The subject is electric signalling, telegraphs, telephones, and recent developments and applications of electricity. Admission is free.

Compound Winding Patent.—The judgment of Mr. Justice Chitty, in the case brought by the Brush Corporation against the Orient Steamship Company for the use of dynamos which infringed the compound winding patent, is of great importance to the corporation, as it establishes the validity of the patent, which, although it has been acknowledged by all the principal dynamo manufacturers in this country, has not hitherto been contested in a court of law.

Old Students' Association.—A general meeting of the City and Guilds of London O.S.A. will be held on Wednesday, December 5th, at 7.45 p.m., at the Central Institution, Exhibition-road, S.W. (near the South Kensington railway station). A paper will be read on "Aluminium," by W. M. Heller. The following points will be dealt with in the paper: History of the metal; its chemical process of production; its electrical process of production; general physical, chemical and mechanical properties of the metal; general properties of its alloys; and its industrial applications.

Catalogue.—We have received a neat catalogue of electrical apparatus from Messrs. Gent and Co., of Faraday Works, Leicester, mostly for use in electro-medical treatment. In this are illustrated galvanometers, milliampere-meters of horizontal and vertical forms, resistances electrodes, and batteries of many kinds—dry, portable, and constant. Complete cabinets of electro-medical apparatus are shown for consulting-rooms, and cauteries, tongue depressors, and lamps for surgical use are numerously adapted, together with other instruments used in electro-therapeutics.

Underground Wires in the Strand.—The London Electric Supply Corporation have requested permission from the St. Martin's Vestry to lay an underground main in Durham-street from the Adelphi-arches, across the Strand to the passage leading to the premises of the Corps of Commissionaires; and the clerk having reported that the agreement proposed had been so drafted as sufficiently to protect the interests of the vestry, it was agreed that the draft be approved, and an agreement entered into with the corporation in accordance therewith.

Barnet.—We note that the representative of the *Electrical Review* has now seen the light at Barnet; the result of its verdict is still, briefly, *Veni, vidi, damnavi.* Our contemporary has now a perfect right to its opinion; we gave a different one, and gave our reasons. The point of view is not brilliance of display, but replacement of gas and the commercial carrying out of the contractor's undertaking. Mr. Joel had accepted a contract, and what we objected to was the utter unfairness of condemning work upon hearsay evidence, or discouraging electric light enterprise by a judgment based upon remarks of the gas journals. The final result must rest, of course, with the people of Barnet.

The Institution of Electrical Engineers.—The new title of the Society of Telegraph-Engineers and Electricians, as unanimously approved by resolutions respectively passed and confirmed at special general meetings of members, held on the 8th and 22nd November, is "The Institution of Electrical Engineers." As stated by the president at the last ordinary general meeting, the new title can only be assumed after the consent of the Board of Trade has been obtained, and a new certificate issued by the Registrar of Joint-Stock Companies, and it is expected that these requirements will have been fulfilled in time to enable the society to adopt the new title on the 1st of January next.

Central Accumulators.—Mr. King, of the E.P.S. Company, has had some interesting work pending for some considerable time with accumulators with large plates, for central supply, capable of giving current for 5,000 lamps. This method of storage and distribution will evidently be the nearest approach to the gasometer distribution of gas, and has always obtained favour among the public. We shall probably see these central accumulators used in conjunction with the Chelsea station in subsidiary centres. They would be charged in series from a central generating station, regulated from thence without need of constant attendance, and distribute locally at about 50 volts.

The Subway Company.—We have reason to believe that all obstacles to the use of electric traction have now been got over, not, however, without a substantial *douceur* to the far-seeing gentlemen who bought up the assets of the Cable Corporation. The electrical equipment is, we understand, entrusted to the firm of Siemens Bros., whose large capital and almost unlimited resources will enable them to undertake the entire working of the line at contract price per mile. This will be far and away the "biggest thing" in electrical traction that has ever been attempted, and in such thoroughly competent hands the work is certain to be well done, and we may confidently look forward to a triumphant success.

The Tesla Motor.—The experiments that have been conducted by the Westinghouse Electric Company during the last three months with the Tesla motors are said to

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have been very satisfactory. A form has been perfected that will work on existing alternating circuits for the running of fans and other light machinery, and also the large motors for tramcar purposes, and for power generally, have been brought to a high degree of perfection and efficiency. For tramway work the Tesla motor, having no brushes or commutator, may probably arrive at the ideal stage before Mr. Sprague attains the wished-for waterpoof point, as its promotors claim that it can be constructed so that even if covered with mud and water no possible danger can occur.

Paris-Brussels Telephone.—The cost of the telephone line from Paris to Brussels is already covered in the first year's receipts. The income is now at the rate of 120,000 francs a year. It is proposed to institute a simultaneous service of telegraph and telephone over this wire on the Van Rysselberghe system. The telephone system employed on this line is that of Dejongh, now in the hands of MM. Mourlon, of Brussels, who have obtained a gold medal for the system at the Brussels Exhibition, and have put up a number of telephone exchanges in Spain, Italy, Egypt, and Mexico, as well as in various English and Dutch colonies. The success obtained is greatly due to the absence of the necessity for adjustment, and the extreme clearness of the speaking.

Maxim-Weston.—An attempt is being made to resuscitate this company and obtain the capital required for working by carrying out a scheme which involves the formation of a new company. "As the consideration for the sale to the new company, the shareholders of the old company will receive for every share in the old company held by them one 3s. share in the new company, upon which 2s. will be credited as paid. The balance of 1s. per share will be payable, 3d. on application, 3d. on allotment, and the balance as required, but no further call will be made before the expiration of six months from the date of allotment. A sum will thus be provided sufficient to enable the new company to profitably carry on its business." This company has gone through so many and so queer vicissitudes that it would be a pleasant surprise to find itself in a position to carry on profitable work.

Westinghouse Extensions.—In view of the invasion of Westinghouse into England, it is interesting to learn that this indefatigable company have practically obtained control of the Waterhouse arc lighting system, as Mr. Westinghouse has personally purchased the entire stock of the Waterhouse Company. The Westinghouse Company had a contract with the Thomson-Houston Company to use its arc apparatus, but this terminates on the 30th of November. The Thomson-Houston Company had themselves entered into negotiation for possession of the Waterhouse system, but meanwhile Mr. Westinghouse stepped in and bought the whole lot, together with valuable inventions for the automatic regulation of arc dynamos. The Waterhouse Company has about 5,000 arc lights in operation, and a number of important stations. What with arcs and incandescents, motors and meters, Westinghouse has now a pretty complete system.

Overhead Wires.—It has been thought that the question of overhead wires in Parliament would militate strongly against the operations of the London Electric Supply Corporation, but we understand that experiments are being undertaken for the Board of Trade by this corporation in connection with their Grosvenor installation and elsewhere, and so far everything seems to be going very amicably. In the case of the necessity in any portions of the streets to put the high-tension wires underground, there is no insuperable difficulty about this on account of the high tension, as there is already about two miles of the main primary of the Grosvenor circuit run underground. There is one stretch from the back of the Carlton to the Board of Works, and another from the Isthmian Club to the St. George's, and again from near Mr. W. H. Smith's up to the Royal College of Surgeons. These are laid in 3in. iron pipes, with special rubber coatings, and two layers of canvas tape.

Electric Rents.—The use of electricity is a great inducement leading to the letting of houses, flats, or rooms nowadays. Electric bells have long been introduced; annunciators are following; a telephone for common use is appreciated; the electric light is now a desideratum in good hotels and in flats, and will soon be so in private houses; electric door-openers are coming in; electric motors for lifts, fans, pumps, and knife-cleaners etc., will follow; electric hoists or trams for supply of coal and manipulation of luggage, or even of breakfasts, are worth consideration; electric heaters, water boilers, may also yet become as common as gas stoves. These considerations make us think that the servant question is already becoming a solvable problem, and the query "Is life worth living?" will soon become one of electrical conveniences. The influence of electricity upon the letting power of houses and flats must cause a constantly increasing pressure towards their introduction in all modern buildings.

Electrical Engineering at the Pitlake Institute.—We are glad to see in the *Croydon Advertiser* that an electrical engineering class has been formed at the Pitlake Institute, and that numbering as it does already 50 students, it promises to be very successful. The instructor is Mr. W. Perron-Maycock, A.S.T.E., of Waddon, who delivers lectures, illustrated by experiments on electrical technology, on alternate Tuesdays; the intervening Tuesdays are devoted to practical work. This class is for the working class in general, but more particularly for artisans and apprentices engaged in electrical work, who are taught to fit up electric bells, indicators, etc., in an efficient and workmanlike manner. The fee for the course of twelve lessons is only one shilling, so that all are encouraged to attend the class. Other classes are held at the institute—viz., clay-modelling and casting, drawing and design, Venetian ironwork, wood carving, shorthand, and commercial geography. The director of the whole work of the institute is the Rev. T. Oakley Coles.

Electric Miners' Lamps.—The Mining and General Electric Lamp Company, with a capital of £100,000 and a very strong directorate, has been brought out this week for the purpose of acquiring the patents, system of manufacture, etc., of a portable electric lamp for use in mines, railway carriages, factories, etc., and also for domestic purposes. The lamp it is proposed to manufacture for miners to use weighs a little over 5lb., burns ten to twelve hours, can be sold for 20s., and it is estimated that the expense of maintenance does not exceed 3d. a week. Secondary batteries are used, and the plates of peroxide appear to be an improvement on the old Union type. The time occupied in charging is said to be 8 hours or 9 hours, but this would appear to be rather under the mark. It is suggested that the cost of charging would be inappreciable

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owing to the motive power being generally available at collieries, but we venture to think that such power would in many cases be inapplicable, and special plant would be necessary. However, these are details that experience will determine.

A Crew Disabled by Lightning.—The Guion Line steamer "Alaska," from New York, just arrived at Queenstown, brings intelligence of the ship "Edward," from Havre, with a cargo of iron ore, whose captain reported that the vessel encountered a terrible electrical storm in the Atlantic on the night of the 31st ult., when in lat. 41 42 N., long. 54 42 W., lasting for several hours. The vessel was continuously enveloped in lightning, which prostrated on the deck 11 seamen, and deprived them of sight for nearly half a day. The second officer and the boatswain were also dashed to the deck, and received serious injury, and the former was speechless for five hours. Three balls of fire exploded with a tremendous report over the main rigging, scattering flaming fragments over the ship, and driving the remaining members of the crew in terror into the forecastle. From 3 p.m. until 7 p.m. the captain and mate were the only persons on board capable of doing any work, and on them devolved the task of keeping the vessel before the easterly gale. The captain states that all on board the ship were trembling with fear during the time that the electrical storm lasted, which was the most terrible he ever witnessed, and he adds that no doubt the iron ore with which the "Edward" was laden served to attract the lightning.

Tramway Tax.—In view of the probable large extension of the street tramways under new systems of electric traction, it may be well to call attention to the vested interest which in some cases the population, or the municipality acting for them, are considered to possess over the right to supply their own wants. These wants argue a certain demand, corresponding somewhat to goodwill in established firms, and it is a coming question whether the right to supply these wants should only be granted with the proviso of a proportional privilege tax on profits, for the benefit of the municipality and the reduction of direct taxation. At any rate, this is the attitude taken by the authorities at Panama, in the case of a street tramway. The contractor has a franchise for 50 years, during which time a privilege tax of 20 per cent. of the net profits is to be paid, and at the end of that time the road and all appurtenances revert to the municipality. It is not suggested that this is an ideal arrangement for the encouragement of tramway enterprise; but it should be always remembered and recognised that the inauguration of schemes in which public demand is a factor, are, or should be, primarily for the benefit of the public in providing them with the means to utilise this demand in the best and most extensive way, and not for the providing of a means by which the greatest number of persons possible can be enabled to live in idleness in perpetuity upon a practical monopoly of the wants of the population.

A New Accumulator.—M. Camille Faure, the well-known inventor, who is now, we learn, working in conjunction with the Electric Accumulator Company in the United States, has just taken out a patent for an accumulator new in its arrangement and in the nature of the active substances employed. These active substances are composed of finely-divided metals, compressed, and contained in an asbestos diaphragm or septum. The asbestos septum is of pasteboard, less than 1mm. thick, soaked in a solution of a soluble salt, such as chloride of sodium or barium. This asbestos sheet is then dried and soaked in a solution of a soluble silicate, capable of producing in this way an insoluble compound. The metallic elements thus prepared are placed in an electrolytic solution, forming an insoluble compound with the metal or metals composing one or both of the elements of the accumulator. With zinc and copper, for instance, M. Faure uses potassium phosphate as the electrolytic solution. The passage of the charging current forms insoluble phosphate of copper. M. Faure replaces the solution exhausted by the electrolytic action by a fresh solution of phosphate of potassium. The discharge is then effected by the passage of the phosphoric acid from the copper to the zinc, without alteration of the solution. A current in the reverse direction causes the phosphoric acid to pass from the zinc to the copper, and so on. The first operation could evidently be avoided if phosphate of copper were taken to start with, but as difficulty is experienced in the preparation and manipulation of this substance, it is preferable to obtain it by the electrolytic process indicated. Details are not yet given of the E.M.F., the constancy, the life, the power and the capacity of the new accumulators of M. Faure, and it is therefore impossible to judge whether they have qualities which will enable them to replace commercially the oxide of lead types. It is to be hoped that the author will shortly complete the descriptions, which are necessarily a little vague in his patent.

Hotel Mont Dore.—Additions have lately been made to the Hotel Mont Dore, Bournemouth, embracing the application of several of the most modern developments of engineering. A handsome dining-room for 100 guests, with private suites above, has been added, and opposite are a winter garden and a covered tennis court, fitted with a gallery at one end, and a platform and organ at the other, rendering the building available for concerts. The whole of the hotel and recent additions are fitted with electric light, about 300 lamps being employed, ranging from 8 to 16 candles. The power is supplied by a 20 h.p. vertical engine and dynamo combined, of the well-known Raworth type, manufactured by Messrs. Browell and Lindley. The machinery has been supplied by the Anglo-American Brush Corporation, and the connections, lamps, and fittings by Messrs. Edmundson and Co. An hydraulic lift service has been erected by Messrs. Archd. Smith and Stevens, Queen's-road, Battersea, and this is also fitted with electric light. The movement of the controlling valve is automatic, and immediately a lift commences to ascend the pump starts into motion, and continues working till the water consumed is replaced, when it stops in the same manner, only to restart at the next draught of water, the entire system being automatic and silent. Steam is supplied for the electric, hydraulic, and pumping machinery, and for heating and cooking purposes by a 55 h.p. Babcock and Wilcox boiler, carrying a pressure of 90lb., and reducing valves are supplied for the cooking and heating systems. A Worthington duplex pump is used for separate water supply, and a pumping plant, with Otto gas-engine, is employed to supply sea water direct from the shore, a quarter of a mile distant, to the baths. The work has been carried out under the superintendence of Mr. S. Chadwick, Parliament-street, as architect, and Mr. K. Mackenzie, of 15, Great George-street, as consulting engineer, and is a very good example of the co-operation of mechanical, hydraulic, and electrical engineers.

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NOTES ON CHOOSING AND INSTALLING ELECTRIC LIGHT PLANT.

BY L. A. DAVIES, A.S.T.E. AND E.

(Concluded from page 403.)

The question of the superiority of an installation in which the lamps are fed from accumulators or transformers is one of the most interesting subjects of discussion amongst electrical engineers connected with central station work at the present moment. The competition between the two systems does not, however, exist in the case of compact local installations where the motive power, generator, and lamps are all in immediate proximity to one another. Under such circumstances the reduction in prime cost of conductors obtained by the use of transformers would be immediately swallowed up by the cost of the transformers themselves, to say nothing of the cost of the expensive insulation required on the primary leads. As the leads become shorter, and the economy of transformers decreases, the economy of accumulators increases. The chief argument against their use for central station supply is that they necessitate the employment of heavier and more costly mains than need be used with the transformer system; but where the mains are short, and have in any case to be laid, as in a local installation working with continuous currents, this objection no longer exists. There is still the consideration of their own heavy first cost, but against this must be set their great advantages of affording a continuous supply, and of doing away with all the risk of interruption to the lighting incident to its maintenance from running machinery. Accumulators will also act as an excellent and automatic regulator on an irregular source of current. They give little trouble, and if properly put down and treated they will last a long time, and when worn out they are renewable at a small cost. It was expected that the price of accumulators would be much reduced as experience was gained in their manufacture, but though this has not been the case to so great an extent as was hoped, very great improvements have been effected in their construction, with the consequent attainment of a much increased life, and so a similar result arrived at, though by a different route. The convenience and other advantages obtained by their use well repays the necessary additional outlay, and their adoption for private lighting is strongly recommended.

The cost of an installation of accumulators depends upon the number and size of the cells required. A certain number of cells in series is necessary, varying with the voltage, and this number is altogether independent of the size of the cells. As each cell affords a normal E.M.F. of 2 volts, the necessary number of cells in series will equal half the voltage of the lamps, or difference of potential needful between their respective positive and negative terminals, plus an extra cell or two, to compensate for loss in the leads. The usual voltages of incandescent lamps are 30, 50, 60, and 100 volts, and sets of 16, 27, 33, and 53 cells in series are respectively necessary for use with them. The size or number of plates in each cell depends upon the amount of current of the required discharge, and the number of hours for which it has to be maintained. The maximum rate of discharge which can be safely taken from a pasted plate is 6·1 amperes per square foot, or four amperes per positive plate in an E.P.S. or Elwell-Parker cell. The total discharge necessary equals the current required through each lamp multiplied by the number of lamps in parallel, so that to find the size of cell required divide this value by 4, and multiply by 2, and add 1 for the odd outside negative, or if

S = size of cell,
n = number of lamps,
c = current through each lamp,

$$S = 2\frac{n \times c}{4} + 1.$$

For instance, an installation of forty 30-watt lamps, taking a current of ·6 amperes at 50 volts, would require a set of 27, and

$$S = 2\frac{\cdot 6 \times 40}{4} + 1 = 13\,L$$

13 L cells are not usually made, the ordinary sizes being 7 L, 11 L, 15 L, 23 L, and 31 L; and for so small a number it would be advisable to put down 15 L cells, and discharge at a slightly slower rate for a longer time. Each plate in a cell will afford a certain number of amperes for a certain number of hours, and these two factors may be proportionately varied; always provided that the maximum rate of discharge per unit of surface is not exceeded. The total number of ampere-hours obtainable from a cell increases with the number of plates in parallel in it. There is a practical limit to this number of plates, and this is reached when the cell becomes inconveniently bulky and heavy. A 31 L cell complete, with acid and glass box, weighs nearly 240lb., or considerably over 2cwt., and beyond this it is not convenient to go. A 31 L cell has a capacity of 660 ampere-hours—that is, it will afford a current of 66 amperes for 10 hours, or sufficient for 110 50-volt 30-watt lamps. If a greater capacity than this is required, it is advisable to place two complete sets of similar cells in parallel, each of half the requisite capacity, and charge and discharge them simultaneously for the whole period at a low rate, or charge and discharge them alternately each for half the time at a higher rate. The former plan will be found the most economical, as a considerably higher rate of efficiency, or ratio of work put in to work got out, can be obtained from accumulators at a low rate of charge and discharge than at a high one.

As there is a limit to the safe rate of discharge, so there is a limit to the economical charging rate. The maximum rate of discharge is determined by the mechanical strength of the plate as a whole, excessive discharge causing disruption of the paste. The maximum rate of charge is reached when the maximum of useful chemical work for unit of surface is attained. This obviously depends upon the mechanical construction of the plates, and in the case of the E.P.S. and Elwell-Parker "L" type plate may be fixed at 5·3 amperes per square foot, or 3 amperes per positive plate. To find, then, the necessary charging current for a set of cells, multiply the subtract 1 from the number of plates in each cell, and divide by 2, and multiply by 3, or if

S = number of plates in each cell,
C = the charging current,

$$C = 3\left(\frac{S-1}{2}\right)$$

The E.M.F. of the charging current should be 10 per cent. higher than the opposing E.M.F. of the cells. The E.M.F. of the cells rises slightly as the charge in them increases, and the charging E.M.F. must be increased in proportion. The charging must be continued until the specific gravity of the liquid has increased from 1·170 (E.P.S.), at which it is first put in, to 1·210. The *first* charge should be as nearly continuous as possible, and should commence immediately on the completion of the pouring in of the acid, as it does the plates harm to allow them to stand in the acid without a charge in them. The plates should be completely covered with liquid. Celluloid forks can now be obtained to slip down between the positive and negative plates to prevent short-circuiting through any curvature occurring in the plates, and glass plates to catch any spray given off; these plates are laid convex side down on the upper edges of the electrodes, and the spray being received on their under sides, runs together and drips back into the cell, and is thus prevented from injuring any machinery, etc., in the room. The cells should stand on oil insulators to prevent leakage of current, and the temperature of the accumulator-room should not be allowed to rise much above the normal, or the plates are liable to buckle. Glass boxes are preferable to wooden ones, as they admit of the condition of the plates being inspected. They must, however, be treated with care, or they are liable to crack. To avoid this, the supporting insulators must be so placed and levelled as to secure an equal distribution of the weight—a hot sun allowed to beat upon the cells has frequently caused fracture. The shelves on which the cells stand must be strongly made, as the weight of an accumulator battery is very considerable. As a further guard against leakage, each cell should stand in a stout wooden tray coated with pitch, and having a layer of sawdust. This last precaution, besides absorbing any

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moisture which may run down the sides of the cell, also enables a more equal support to be given to the glass boxes, and so reduces the risk of fracture.

The efficiency of secondary batteries has been variously estimated. Sir D. Salomon places it at not more than 65 to 70 per cent.—that is, not more than 65 or 70 per cent. of the total work done in charging the cells can be obtained again in actual work done by them. The cells when once charged should never be completely discharged, or "sulphating" will occur. If sulphating has set in, the positive plates, instead of being of a deep brown colour, will be more or less covered with grey patches. The best remedy is to pass a charging current through them until the positives regain their normal colour. Sulphate of lead being a bad conductor, the working surface of the plates is reduced by its presence, so the charging current should be proportionately kept down at first, but may be gradually increased to the maximum of three amperes per positive in parallel as the sulphate disappears. The cells should be inspected at intervals to see that no pieces of scale or plugs of paste have lodged between the adjoining positives and negatives. An incandescent lamp of suitable voltage, connected by flexible leads to the terminals of a sufficient number of cells in series and carried in a portable holder, will be found very convenient for this purpose. The best guides to the condition of a cell are, first, the colour of the edges of the positive plates, the specific gravity of the electrolyte as measured by the small hydrometers made for the purpose, and the E.M.F. of the cell which can be measured on a suitable low-reading voltmeter. The positive plates should be kept of a deep brown tint, the specific gravity of the liquid should not be allowed to fall below 1·190, and the E.M.F. of each cell below 2 volts.

A shunt dynamo should always be used for charging accumulators, as, unlike a series machine, its polarity cannot be reversed. If a compound dynamo is adopted, in order to admit of running a portion of the lamps from it direct whilst the battery feeds the remainder, a switch should be provided to break the series magnet winding, or, better, to add these coils to the shunt in series with them. A resistance coil in the shunt circuit is a great convenience, as it enables a perfect control to be obtained over the E.M.F. of the charging current, without varying the speed of the machine. Care must be taken, when first connecting up the battery to the dynamo, that the free positive plates of one of the end cells (usually painted red) are connected to the positive terminal of the dynamo. To make quite sure as to which is the positive terminal of the machine, a simple test may be made by connecting two pieces of lead to the two terminals, and immersing them in a vessel containing some acidulated water, when on passing the current the lead connected to the positive will become coated with the brown peroxide.

There are various devices supplied by makers of accumulators for breaking the charging circuit if the E.M.F. of the charging current falls below the required value for automatically putting in or cutting out cells to maintain the E.M.F. across the lamp lead terminals constant for giving an alarm when the rate of discharge becomes excessive, etc. These apparatus add slightly to the first cost of an installation, but repay this by the additional security from trouble obtained by their use. They need not, however, be described here. In conclusion, though accumulators may, and doubtless will, be improved as time goes on, they are now thoroughly reliable and practical apparatus, and with ordinary care and attention will give every satisfaction both from the freedom from fear of breakdown and stoppage, from the continuous supply always available for illumination at a moment's notice, and from the scientific interest aroused by their management and action. There are unpasted cells now in the market which admit of a far higher rate of charge and discharge, but owing to their recent introduction much information is not as yet available as to their life and ease of management.

Using it Up.—One of the underground caves in Virginia, we read, has been lighted with a 650 light plant. Only half this number is found necessary, and a large hotel is being built at the mouth of the cave to "use the surplus light."

PRITCHETT'S HOLBORN LIGHTING STATION.

While so many public companies are establishing central electric lighting stations all over London, and vieing with each other for public favour, it may be worth while to see what private enterprise is contributing in this direction. One or two persons in the swim know of the installation we are going to describe, others have vaguely heard of it, but probably a large number of electrical men hardly know of its existence. Two gentlemen, one an architect, the other a promising electrical engineer, Messrs. Pritchett—father and son—put their money and their heads together, selected a thoroughly suitable site, put down some engines, and gave an order to the Brush Company for an alternating and an arc-light plant, ran some overhead wires: result, a flourishing installation, bidding fair to become one of the principal supply stations of a most populous district in London. It is a matter of note that, besides the Grosvenor, this station is the only one distributing electric light on the high-tension alternating transformer system at present at work in London.

This installation will be noted in the history of electrical development as being the first in which the now well-known Mordey alternator was used; the result of the application of Messrs. Pritchett to the Brush Company for an alternating plant being the production of this alternator, which is evidently destined to take its place amongst high-tension dynamos. The Mordey alternator has already been described by us in a special article on its first manufacture, and also illustrated in our article (Aug. 10) on the works of, the Brush Company. It is only necessary, therefore, besides referring to these, to mention that in the Mordey alternator the heavy field-magnets are made to revolve instead of the armature. These magnets are in the form of a north and south pole with curved circular ends, like a huge mushroom, each slotted into nine pole-pieces, all the north poles being on one side, and all the south poles upon the other side of the armature. By this arrangement several great advantages are secured; first, the heavy and strong part revolves while the delicate part—the armature—stands still; secondly, the heavy magnets act as a flywheel, and the result is great uniformity of light, the lamps being practically as steady as when on accumulators; thirdly, the whole of the south magnets being on one side of the armature the complete magnetic circuit passes through the armature coils, and there is no magnetic leakage from the sides of the poles, as inevitably is the case to some extent when alternate poles are used; and the dynamo is therefore very efficient. Besides these advantages, the dynamo is so constructed that any coil can be taken out without disturbing the remainder, and a new coil inserted with very little trouble. As an instance, when the alternators were first put down, a coil in one machine went wrong. The circuit was switched on the second machine, the coil was unsoldered, taken out between the poles of the magnet, replaced with a new one, and the machine was again running within 20 minutes—a feat which it would be impossible to accomplish with the ordinary alternate current machines. These alternators give 2,000 volts, and supply current to transformers for 750 16 c.p. lamps each. Each coil has generated in it a pressure of 112 volts, and contacts are made on the outside of the dynamo from a single coil in order to regulate the pressure, and this is connected to a voltmeter and a test lamp. This avoids connecting the high tension circuit. The speed is 650 revolutions per minute; the diameter of the pole-pieces is about 3ft. 6in., and the weight about one and a quarter tons.

The general arrangement of the station is shown in the accompanying plan. The station is situated in Black Horse-yard, out of Rathbone-place, near Tottenham Court-road. The space at disposal is considerable, and admirably adapted for an electric light station. It consists of a large basement in a triangular space under warehouses, etc., and was already fitted with a large brick chimney shaft. Only a small proportion of this roomy basement is yet occupied, space being available for a very large addition to the boilers and engines.

The plant already at work consists of two engines, with two large alternators and their exciters, and a 16-light arc

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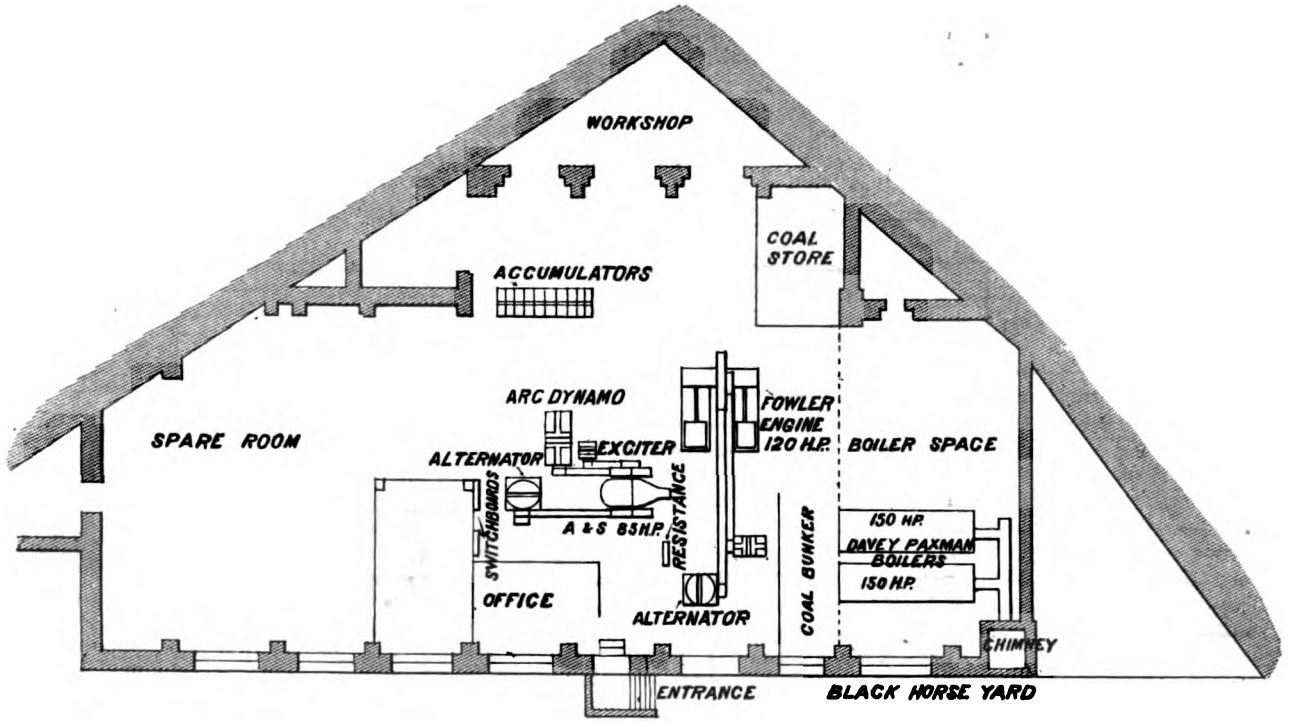
Brush dynamo. The boilers are two Davey-Paxman steel boilers, locomotive type, capable of generating steam for 150 h p. each at 100lb., and will work up to 140lb. pressure. The plant is divided into two sets : No. 1 plant is driven by an Armington and Sims high-speed engine of 85 h.p., working at 300 revolutions. This is found very satisfactory, gives little trouble, and takes up very little room as compared with its power. This engine drives, as shown in the plan, one of the Mor ley alternators and the 16 arc dynamo, and also drives the small Victoria shunt-dynamo, which serves as an exciter to the field-magnet core of the alternator. This plant is loaded up to or over its full power on the transformer circuit, supplying current equal to about 850 lamps of 16 c.p. A separate direct current circuit is run for the arc lamp, of which about 12 or 13 are now in use. Brockie-Pell lamps are used and run very steadily. This plant is run up to three o'clock in the afternoon.

The second plant consists of a 120 h.p. stationary engine by Messrs. Fowler and Sons, of Leeds; it is a double cylinder, high-pressure engine, working at 120 revolutions per minute, fitted with Hartnell's governor, and has won the highest praise from the users in this station for its purpose in electric lighting. This drives a second alternator fixed together in a neat cast-iron frame, so as to be hung up on nails on the wall. For more than 25 lamps the transformers are usually arranged two in series, with 1,000 volts only at the terminals of each. The size is 2ft. long by 6in. square; they are usually placed in a fireproof cupboard, and give no trouble after the first fixing. The charge for current is usually at the rate of £2 per 16 c.p. lamp, and £1 per 8 c.p. lamp a year, for ordinary hours, and by special contract in certain places. Victoria unflashed lamps, by the new process, are used throughout and give great satisfaction, being even more regular in light, it is said (which was hardly to have been expected), than the previous flashed lamps. Eight and 16 c.p. lamps are used, the larger number being of the smaller power. Some 32 and 50 c.p. lamps are also running in some of the shops.

The circuit supplied from this station extends along Oxford-street as far as Cavendish-square, down Regent-street, along Argyll-street, to Great Marlborough-street, to Berners-street, Newman-street, and Great Portland-street, etc., and up to the Middlesex Hospital. The wires are all run overhead, and no difficulty has been experienced in the running of the leads, with the exception of the initial trouble in obtaining way-leaves. A large number of further customers are in treaty for the



Plan of Pritchett's Holborn Lighting Station.

for 750 lamps, which is not quite up to its full load. Some 2,000 lamps of 8 and 16 c.p. altogether are on circuit. The two engines are run together up till 8.30, and after that, one engine is again sufficient. Supply is kept on from 7.30 in the morning till 12.30 at night.

A set of 35 accumulators are arranged so as to supply light for the station itself when not working, or for other purposes. These are charged in series with the arc lamps from the Brush dynamo. An automatic carbon regulator is arranged in the arc circuit, and a two-way double-pole switch allows the accumulators to be cut in or out as required. A Miller's engine-room ammeter, by Sharp and Kent, for 10 amperes, gives very good results, and has a neat appearance. The switchboard from the alternators is arranged in a convenient position, as shown, and allows either alternator to be put on the circuit.

The exciters for the alternators are the ordinary shunt-wound Victoria dynamos, giving 25 volts and 60 amperes. The regulation of the high-tenson circuit is effected by altering resistance in the shunt coils of the small exciter dynamos. The pressure on the coils of the alternator is indicated in a Cardew voltmeter.

The transformers used in this installation are those designed by Mr. Mordey to work with his alternators. They consist of a long series of stamped pieces of iron, strung together with the two circuits of wire inside, and light, and the plant will be probably greatly extended before next winter. The plant at present running is neat and workmanlike in its arrangement, and appears to give very little trouble. There is plenty of space for additional power to the extent of many thousands of lights. It is intended to put down shortly four other boilers of 500 h.p. each, large coupled engines of 500 h.p., and four or five 5,000 light alternators, and experiments are pending for running these machines in parallel. Other arc lights are ordered, and 25-light arc dynamos will also be added as the demand for arc lamps increases. Altogether this central station is one of the most interesting at present running, and we wish its promoters the success they deserve.

AN ELECTRIC TRAVELLING CRANE.

In describing Messrs. Crompton's works some time ago we alluded to the preparations in course of progress for the manufacture of an electric travelling crane for use in a timber yard in the East End, near the Docks. This crane has now been successfully working for some weeks, the works at which it is used being those of Mr. H. Herrmann, at Dod-street, Limehouse, consisting of large timber yards, wood-working, and furniture factories, extending down the whole side of

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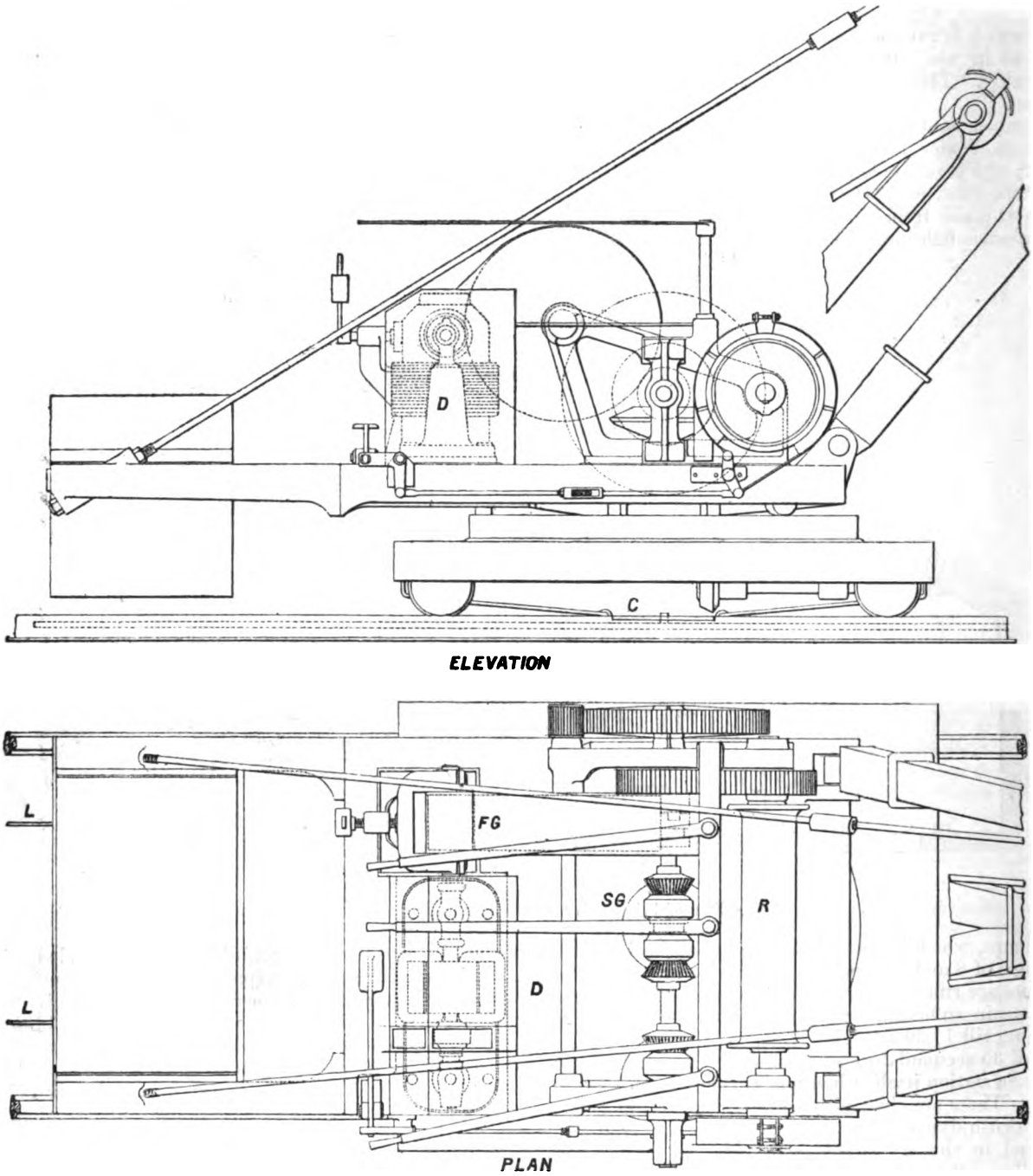
the street. The unloading and manipulation of the rough timber is an important part of the work here continually carried on, and various considerations have induced Mr. Hass, who s Mr Herrmann s representative in the London works, to erect a travelling crane worked by electricity. The first of these considerations is that if a steam travelling crane were used boilers would, of course, be required, necessitating fire and danger of sparks, and this, on the roof of an enormous timber warehouse, would lead to great increase in insurance. Hydraulic power might have been employed; but Mr. Herrmann's works had already a 350-light dynamo several slight alterations and additions being carried out by the workmen on the place. The result has fully justified their faith; the crane is now working admirably, and is under complete control.

Last Friday a demonstration was given of the working of the crane to a number of representatives of the technical journals. A tramway is laid on the roof of the timber warehouse, curved to follow the course of the pathway below. Two copper tubes are screwed upon the wood sleepers, between the rails, to serve as conductors, and the electricity is conveyed by overhead wires from the dynamo-room, and is connected at a point midway along



Crompton's Electric Travelling Crane.

supplied by Crompton and Co., which was used for giving light in the adjoining factory. The idea was entertained of using electricity as the motive power, and it speaks well of the enterprise of Mr. Herrmann that, without having been able to see in actual use any similar apparatus, the order was given to Messrs. Crompton on their assurance that the work should be satisfactorily carried out.

During the construction of this crane Messrs. Crompton have been ably assisted by Mr. Hollick, acting on behalf of Mr. Herrmann, and after erection points of detail and construction requisite for the nature of the work were found to require attention, and in these Mr. Hass also co-operated, the track. The crane itself has a good deal the appearance of an ordinary steam travelling crane, but boxed in with match-boarding, and of course without boilers, which are usually conspicuous. A mirror is arranged to show the driver what is going on below.

The crane is driven by an electromotor geared with friction gearing to a centre shaft, and from this shaft, by the means of three levers in combination with one foot-brake, the various motions of hoisting, slewing, and travelling are accomplished. The arrangement of the apparatus is shown on the accompanying working drawings, where D is the dynamo, FG the friction gear, SG the slewing gear, R roller for hoisting chain, and C is the contact with con-

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ductors. The motor is wound as on the ordinary shunt motor, but there is the addition of a resistance which takes the place of a main winding outside the shunt. This is only put in circuit at starting to ensure the magnets being fully excited, and to prevent the possibility of burning the armature until it has reached a proper speed. The brushes are arranged like ordinary dynamo brushes, and the motor is arranged to run constantly in one direction. The motor pulley drives the main shaft by friction gear, the pulley being covered with the hard paper surface now generally in use. There is a space of about $\frac{1}{16}$in. between the two surfaces, and on starting, the whole motor is brought up to the shaft pulley by means of a slow screw. The various operations of travelling, hoisting, and slewing are brought about by means of levers and clutches, and a reversal of the direction is obtained by throwing the load upon the opposite wheels of bevel gearing.

The motor works at 110 volts, the current required usually when hoisting is about 35 amperes, when travelling showing about 23 amperes, the two combined 30 to 35 amperes. On its fullest load it will take 50 amperes.

The crane was specified to raise 15cwt. as a maximum load, to raise 10cwt. at the rate of 80ft. a minute, to travel along a curved track at the speed of 80ft. a minute, and to slew at about the same speed. The travelling and the slewing were to be accomplished at the same time. The crane not only accomplishes the work specified, but more—being easily able to raise 18cwt., and hoisting, slewing, and travelling can, if required, be all accomplished at once. The work being done is unloading planks and logs of wood from barges, carrying them through a gate and along a rather tortuous pathway, and hoisting them to the various floors for stacking. The total weight of the crane is about four tons.

On its trial the crane did its work admirably. The convenience over steam-cranes in the matter of readiness to work is obvious, no fires required making up, nor boiler-pressure to attend to; as also in the question of wear and tear, as much less weight has to be carried. In addition to the saving in insurance, the actual cost in running is less than that of a steam-crane. The arrangement of gear in connection with an electric motor will be readily applicable to derrick cranes, and all kinds of hoisting and travelling gear.

DOUSE'S AUTOMATIC FIRE CHECK.

This fire check, which we mentioned in a recent note, will be more readily understood by an examination of the

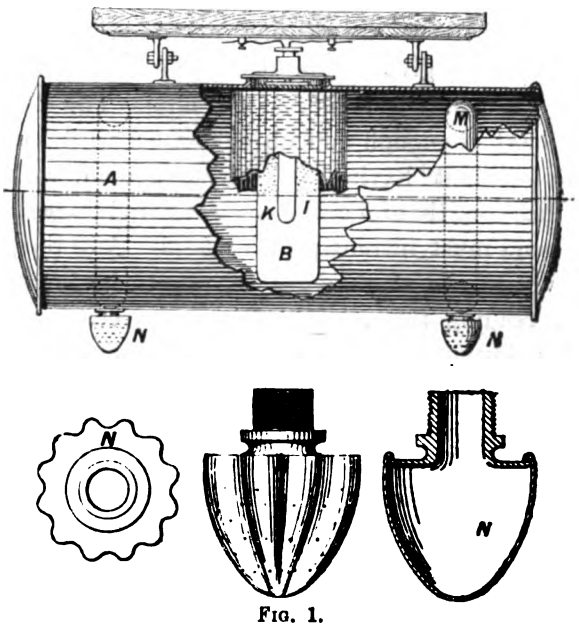

Fig. 1.

accompanying diagrams. Fig. 1 shows a vessel, A, containing a quantity of water with alkali in solution, and this vessel is placed near the ceilings of buildings which it is required to protect. B shows an internal glass vessel filled with an acidulated liquid. If the vessel B be broken or emptied into the vessel A, the contents mingling, the result will be the generation of carbonic acid gas. The formation of such gas gives rise to pressure, which forces the liquid in A out of the tubes, *m*, by way of the sprinklers, N. The form of the sprinklers is shown by the diagrams beneath the vessel A in Fig. 1. These are designed to scatter a spray of water, or rather, we should say, a mixture rapidly generating carbonic oxide as effectively as possible. The vessels employed in a house

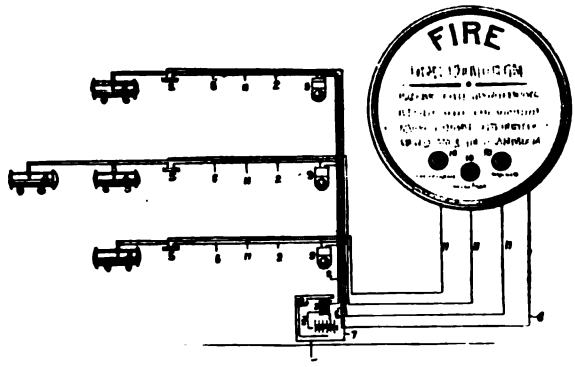

Fig. 2.

or factory are distributed according to the requirements, and connected in pairs or singly, as shown in the diagram, Fig. 2, to a detector, as shown in Fig. 3, the latter being set to make contact at a certain temperature. A fire occurring in any apartment quickly raises the temperature to the point at which the thermostat is set, and by the connection shown in Figs. 1 and 2 the action

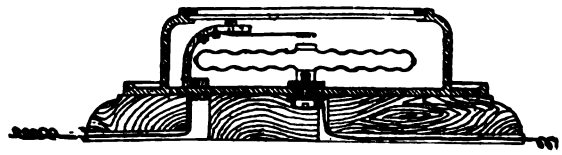

Fig. 3.

designed is carried out; that allows the acid and alkali to mix and the water to be driven out of the vessel and sprinkled over the fire. At the same time the circuit is completed with an electro-magnet, shown in Fig. 4, and the magnet attracts the armature, which is used (as shown) to support a valve in the bend of the gas-pipe. The valve is held in its place against the resistance of a spring so long as the fire check answers, but immediately upon the rise of temperature in any apartment, the sprinkler commences to act, the armature is attracted, and the valve closes, cutting off the gas at the entrance into the building, and thus preventing increase of fire from any gas leakage. There is no doubt

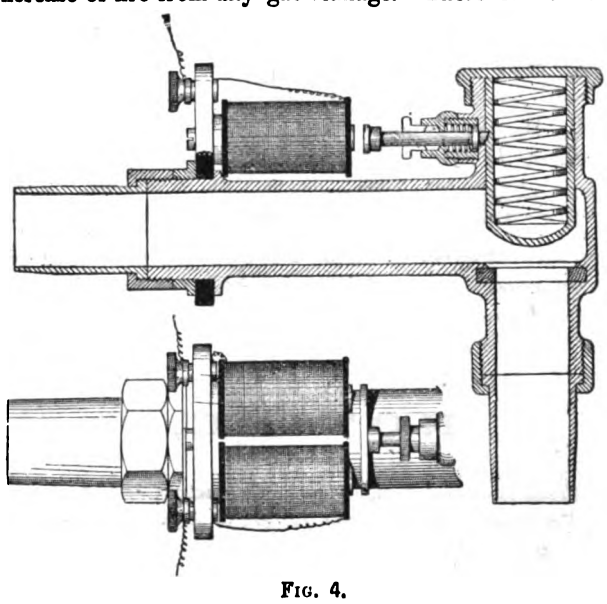

Fig. 4.

but that in many cases the leakage of gas into burning buildings is the means whereby the fire is kept sufficiently intense to prove wholly destructive, and any successful attempts to automatically close the gas supply at the commencement of a fire cannot but be viewed in a most favourable manner.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

FRIGHTENING THE WORKMEN.

The following is a copy of a notice framed and put up in a prominent position in the premises of Mr. Henry Heath, Oxford-street, where electric lighting on the transformer system has been recently introduced:

CAUTION.

You are requested to observe the following instructions, and to endeavour to see them observed by others:

The electric cable is enclosed in casing as shown.

[Sample.]

Do not drive a nail into such casing, nor tamper with it.

Do not allow the casing to become wet by any means. The fuses on the small glass boxes must not be touched.

The MAIN CABLE is on the roof of No. 109 house, and is fixed to the back wall; it is carried under the skylight, beneath the compo, from east to west, and is passed down the south side of the pier to within 10 inches of the floor, where it turns over the front of the pier down to the basement and main switch.

The MAIN CABLE is dangerous, and any interference with it may end FATALLY.

Do not accept the common error that a main cable may be touched with one hand without risk, as perfect insulation cannot be insured.

By order, HENRY HEATH.

The general idea of this notice is excellent, and we strongly recommend the imitation of this custom by the placing of a notice with reference to the electric light casing and the direction of the mains in all premises where workmen are about. But we object slightly to the manner in which the notice will serve to give an impression that the electric light is universally dangerous and fatal. The electric light has had enough difficulties to meet with on this score without having it spread abroad, without qualification, that touching an electric light wire with one hand must instantly prove fatal. And this, we believe, to the average reader, would be the effect upon reading this notice. True, it specifies main cable; but the notice is for untechnical people; electric cables are mentioned just above, and a specimen of the casing which covers them is nailed upon the notice; the consequent effect would naturally be to inculcate the belief in the great danger of any electric light wires, and of considerably frightening all the workpeople. On enquiry, this, the electrician said, was exactly the effect they wished to produce; a wholesome frightening would prevent any meddling whatsoever with the wires.

Now, it may be quite right to prevent workpeople from touching or interfering with the wires, but a frightening of this kind is rather too much a return

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to the policy of the dark ages, and also has the effect of making people say, "Mr. Heath has the electric light, but he has found out, what the electricians wanted to hide from us, that really if you touch an electric light wire with one hand you will be killed instantly"—an idea in itself utterly untrue, and damaging to the interests of the electric light industry. Would it not be better to inform the workpeople that the high-pressure wires to the transformers alone are dangerous; that the greatest care has been taken to thoroughly insulate them so that no danger or fatal shock can result, and the greatest care must be taken not to touch or interfere with these in any way; and that the wires to the lamps are not dangerous to life on accidental touching; but also that a short circuit (resulting immediately in a flash or fire) may be caused by any meddling with the lamp wires by any person not properly authorised? The danger of short circuit at the lamp terminals, of dampness, or of carpenters or other persons driving nails into the casings, are real ones to be well guarded against; but the danger of shock from the high-pressure primary wires is, or ought to be made, infinitesimal. There is virtually no possibility whatever of getting a shock—anything more than the slight titillation of the fingers—from any secondary or lamp wires now in use in houses. While electrical engineers are busy in combatting the erroneous ideas often obtained with regard to the imaginary dangers of electric light in private houses, it is a pity that responsible persons should take the position of advocating the extension of a belief these imaginary dangers amongst their employés. A knowledge of the real dangers to be apprehended would be a much better effect to aim at than an irrational frightening of the workpeople.

LITERATURE.

Central Station Electric Lighting.—By KILLINGWORTH HEDGES, M.I.C.E. [E. and F. N. Spon, London.]

This little book, by Mr. Hedges, on central station lighting is the first of its kind, and its defects must, therefore, be treated with leniency. It is avowedly of a popular and not of a technical nature, so that, while engineers will gain little by perusal of the book and will probably put it down with a feeling of disappointment that the author has not produced something more worthy of his reputation, the reader who has not studied the progress of electric lighting, and who has but a slender knowledge of electricity, will get a fairly good general idea of the methods of electric distribution from central stations; of the cost of electric lighting relatively to that of gas; and of some of the conditions which govern the charges made to consumers.

It is much to be regretted that the explanations of the technical terms in the glossary are of so poor and unscientific a quality. We cannot refrain from expressing our opinion that they are quite unworthy of an engineer in the position of Mr. Hedges.

In the next edition we hope to see the candle-power of lamps always stated when details as to their cost are given—this is omitted, for example, on pages 5, 88, 89, 90, and 91; that Mr. Hedges will give some further particulars as to the plants at the different central stations described, as this is one of the most interesting things in connection with central station lighting; that he will give Mr. Edmunds' system a greater amount of space, as it is on a carefully worked-out scheme; that he will cut out the tables on pp. 74, 75, 105, and 106, as they are of a kind useless to general readers, and that he will devote the space thus obtained to expanding and improving his glossary.

We must repeat that the book is likely to give a good general notion of central station lighting to non-technical readers—the position at present being shown very clearly in the excellent tables of Appendices I. and II.

REPORTING PROGRESS.

DEPTFORD.

The work at Deptford is proceeding apace. A few particulars of the state of progress may be interesting. Anxious enquiries are often made as to whether any of the 10,000 volt main cable is yet run. Well, it is, and it is not: that is to say, if reference is made to the 2½in. concentric main which is to connect London to Deptford, none of this has been run. Samples only have been made, and the company are at present waiting for an automatic covering machine, which will probably be delivered next week, and the manufacture of the large cable will then be proceeded with at once. Satisfactory trials have been made with the sample cables, the chief difficulty found being the surface insulation at the joints, which has been successfully overcome with a sort of collapsing set of concentric ebonite tubes, this together giving a surface of some feet, in a space of a few inches. The position of the transformer stations are practically settled at Cannon-street, Ludgate-hill, and Charing Cross. The first one in operation will, it is understood, be the Charing Cross transformer station, which is situated in basement premises at Maiden-lane. The fourth transformer station will be at the Grosvenor, and from Maiden-lane to the Grosvenor the main primary circuit will be overhead, and it is this portion of the 10,000 volt circuit which is already run. It may be thought dangerous or impossible to successfully run such a circuit with overhead cables, but the step already long taken, from the ordinary 100 or 200 volts (which has no sparking distance) to that of 2,400 volts (which has a sparking distance of $\frac{1}{16}$th of an inch or so), is far more than from this latter pressure to four times its amount. No serious difficulty has been encountered with the distribution of the present high-pressure wires; the insulation has not suffered, and even, which seems extraordinary, wet or damp weather does not seem to affect the insulation to any very appreciable extent. There is, therefore, no great difficulty expected in transmitting 10,000 volts overhead by a pair of insulated cables from Charing Cross to Bond-street. The cables have been specially manufactured by the India Rubber Company, and consist of 61 strands of copper wire, ·06in. diameter (very nearly No. 17 gauge). They are doubly insulated with extra thick rubber, having a resistance of 60,000 megohms. They will be slung on supports at rather greater distance than the ordinary Grosvenor primary wires, otherwise they will be run in much the same way.

It is intended eventually to institute secondary transformer stations for each street, block, or group of houses, as these become connected up together. At present nearly every house has its own transformer, as often it may be the only one in a street; but as private installations become more numerous it will be advantageous to connect them with one transformer only. This will not only greatly decrease the amount of high-tension primary wire overhead—itself an important point in municipal economy—but will also, of course, reduce the number of connections to be made on the high-pressure wire. The resistance of the lines may be almost infinite at first, but as each connection reduces this in a certain degree, however small, an almost infinite number of connections would reduce the insulation resistance to ohms merely. The insulation resistance at present on the Grosvenor does not suffer, being well in the megohms.

There is, by the bye—we have it on the best authority—

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not the least truth in the supposition of a contemporary that paraffined paper is the insulation to be used on the main concentric cables. The prudence of Mr. Ferranti, therefore, is not in question as to this point, and the experience of the editors in the manufacture of condensers will not be required.

We note that a French contemporary in remarking upon this installation says: "The English, after having hesitated for a long period before erecting central electric lighting stations, are throwing themselves to-day into this species of enterprise with an incontestable temerity." They proceed to remark that it is comparatively easy to construct a station for 250,000 lamps if sufficient financial resources are forthcoming, but far more time will be necessary to connect the customers, and still more to fit up their installations, and asks whether there are sufficient electrical contractors to fit up 25, 50, or 100 thousand lamps a year. Looking at the time now taken to complete comparatively small installations, they would consider that the Deptford station will be five, or even ten, years before it is actually supplying 250,000 lamps.

We do not think much fear need be expressed upon this point. There are 33,000 lamps already working at the Grosvenor as a first instalment, and some 5,000 more ready to connect if the power were ready. We should have little hesitation in believing that 150,000 lamps will be supplied from the Deptford station in a twelvemonth after the supply is ready.

It is expected that the first set of 10,000 h.p. dynamos and engines will be ready for supply of current in March next.

SARDINIA STREET.

The work of clearing and building at the Sardinia-street station is going on might and main, the men working night and day in clearing and building operations. The work is to be on the most approved mechanical engineering system. The station, as already announced, will be for 25,000 lamps at first, and the space will be arranged for an increase to 40,000.

The explanation of the Westinghouse contract appears to be somewhat as follows: The directors had settled upon an alternating transformer system, and contracts were invited from some ten or a dozen English firms. Westinghouse was also asked to compete, and was below all of the English tenders. The best English tenders were from firms who had never yet actually carried out a large alternating central station (other alternate dynamo makers being obviously not desirous of tendering), and although it was felt somewhat invidious to give the contract to Westinghouse, and feeling at first ran high against it, the arguments in favour of giving the contract to a company who had already carried out 118 central stations, and to whom this, though larger, would be only the 119th station, carried the day. All the methods of connecting dynamos, running circuits, switchboards, etc., would be more or less cut and dried, and the directors, having in regard the absolute necessity of having no chance of failure, or need of experimental work for a first enterprise, let the contract go to America. This is not the only station they have on hand, however; fuller and more complete specifications are prepared, and are, or will be, sent to the English firms competing, and the next order is promised to English firms.

The Metropolitan Electric Light Company have several other sites in hand for the establishment of similar central stations to that at Sardinia-street. One of these is in the City, another further in the West End, a third will be eventually constructed at the site over Waterloo Bridge, for Lambeth and the surrounding district, a fourth, also towards the West, is under negotiation, making, with the central one at Sardinia-street, and the present installation at Whitehall Court, a total of seven proposed stations.

The contract for Westinghouse has not yet been actually signed—though the directors are practically committed—owing to some little difficulty with obtaining actual legal powers for the site, some of the ground being leasehold and some freehold, but this will be settled almost immediately. Much of the Westinghouse plant is already in England, the remainder can be rapidly constructed, and the installation will probably be running early in the year. It is possible that supply for as many as 100,000 lamps will be ready by this time next year.

WEST AFRICAN CABLES.

Apropos of the note in our last issue relative to the proposed extension of the West African system to the Cape, where it would connect with the Eastern and South African Co.'s cables, it is to be hoped—for the moment is propitious—that more attention will be given to the question of placing the Congo in telegraphic communication with Europe. We are acquainted with the difficulties hedging in the enterprise, but they have also their remedies. They, the difficulties, have been the subject of much discussion, but as yet nothing, or comparatively nothing, seems to have been urged on behalf of the districts which such communication would benefit, nor so far as we have seen and heard has a practical proposal been put forward to meet and obviate the dangers to cable life presented by the outflow of the Congo. It may not be generally known that the Congo current is very swift and powerful, extending as far as ninety miles out to sea. During the rainy season, from December until April, the knottage of the current flowing to the W.N.W. is probably not under six knots per hour, and the volume of coffee-coloured water, branching out to sea like a fan, with its handle between St. Antonio and Banana, may be distinctly traced some thirty miles to the north-westward. This in itself might seriously prejudice a cable laid north and south within appreciable distance of the rivermouth, but the great objection lies in the formation of the river bed, out of which a very deep and wedged-shaped gulf has been worn during long years by the resistless rush of the waters. The problem, then, which has confronted engineers on this coast has been one hard of solution, and it is not surprising, if from want of experience of the locality and want of time to obtain it, the possible has been overlooked by them.

Before, however, discussing remedial measures, it would be as well to see in what manner it would benefit the world were the Congo and its district to be brought within "business" distance of us, for we must consider the Congo, not as a link of a political chain, but as a commercial centre. The Congo has no political importance so long as the Free State is maintained inviolable by the European nations, but commercially it has more present importance, and probably more future importance than all the cable-connected ports on the West Coast of Africa put together.

Outside of the actual river trade, which exceeds £1,000,000 per annum, the seaports of Landana, Cabinda, Moussoura, Ambrizette, and Kinsembo, in the district of the Congo, each with a rapidly growing trade of its own, are fighting against the greatest enemy to trade in the world—isolation. Though rich in everything that Africa possesses, excepting perhaps gold and diamonds, they have no banking facilities, no means of obtaining intelligence of the European markets, except by monthly steamer, and no possibility of meeting an urgent want, except by telegram *vid* Loanda, should the *monthly steamer happen to call in*. This may seen extraordinary, for surely such a demand should create its own supply. The explanation, however, is an old one. The bulk of the trade is in the hands of monopolists who have their own steamers, and do not want the cable. It is the thousand smaller traders now living hand to mouth who want it. Neither Portugal nor the Congo Free State are in favour of the monopoly; but, as the governors of each of the colonies have said to us, What can we do? The Congo is impassable. We are told the cable would break by attrition, and there would be no end of bother and expense.

The Congo is *not* impassable. As to the other point, ask the Eastern Telegraph Company what difficulties have been experienced with the Porthcurno, Vigo, and Lisbon sections; with the Red Sea 1870 cable; with the Zanzibar-Mozambique section; with the lines in the Grecian Archipelago? What has been done up the Persian Gulf? It is not business to veto a scheme because it may present difficulties; the only thing is, will it ever be successful—will it *pay*? The Congo will pay, or we are egregiously mis-

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taken. It has all the elements necessary to success, and must before many years have passed become one of the richest markets known to man.

What are the relative values of Dakar, Bulama, Bissao, and even Loanda, and Mossamedes compared with the Congo? Loanda and South Thomé are to be distinguished above the rest on account of their coffee industries, but as against coffee the Congo has rubber and ivory. The political considerations environing Loanda are of present moment to Portugal, but until the Royal Trans-African Railway reaches Dondo—and that is a prospect extremely remote—Loanda can do nothing but continue to decay; whilst Portugal is becoming every day more alive to the growing importance of her Congo possessions, poor as they are in comparison with those under the dominion of the Free State.

Cabinda and Landana have made more progress during the past two years under the wise administration of Captain A. j. de Brito das Neves Ferreira, than any other Portuguese possession has made in a century. Ambrizette, annexed eight or ten months ago, is an infant of phenomenal growth. San Salvador is also receiving earnest attention at the hands of the Portuguese Government, and should a proposal, which will shortly be put before the Cortes, for the erection of a telpher line between that place and Noqui, the river port, be carried into effect, the Congo trade will be very greatly increased.

It may be thought that it is as yet premature to take the matter up energetically, that the development of trade will bring its own demand, and make imperative its own supply. That is so, but cables and railways fill a twofold purpose. They are not only superior modes of communication and transport of which existing commerce can avail itself, but they are mighty levers with which a new country may be opened, as an oyster shell, and its interior richness brought forth. They not only stimulate trade, but also produce it.

The difficulties to be considered are briefly:

1. The powerful current to be contended against.
2. The precipitous nature of the river bed.
3. The jealousy of the monopolists.
4. Arrangement of line in such manner as to obtain subsidies from both the Portuguese and Free State authorities.

Taking these difficulties seriatim, it would, we think, be unwise to take a branch line from St. Thomé to Banana Creek direct, but it would be quite possible to take it into Cabinda, which is a Portuguese port, and thence by land-line or cable to Banana, 65 miles. This should also meet the first, second, and fourth objections. Landana, another Portuguese port, is only 22 miles north of Cabinda, on the same coast, and the land-line between the two places would bring in the Chiloango river and Kakongo district. At Cabinda (the capital of the Portuguese Congo) there are always a couple of small gunboats running to Ambrizette and Kinsembo, and again, St. Antonio, the port at the Congo mouth, is but a mile from Banana Creek, so that were the shore end laid at Cabinda (the Portuguese capital) and through it to Free State Port, Banana would be in communication with Europe, *via* St. Thomé. We think this arrangement would obtain, as Portugal in any case would have to keep the line open in accordance with the terms of the International Conference.

Another way to meet the exigencies of the case would be to lay a light type, such as C or D, from Cabinda in the edge of the current, head on, as it were, to Banana, round one of the creeks to Ponta de Lenha, to avoid the cross-current round Boolembemba Point, thence across the river by the islands to Kissanga, down again to St. Antonio, out round Ponta Padrao and on to Loanda, connecting Ambrizette and Ambriz on the way. At Ponta de Lenha, the precipice in the river bed practically disappears, and although we should have here the small excess contained in the bight from Banana to Ponta de Lenha the line would be shorter than the other, and in case of a break occurring from attrition, it would be inside the river, where it could be got at easily, and, moreover, the interruption could never be serious, as St. Antonio is only twenty minutes' pull from Banana, and Ambrizette a few hours' run. There are always a number of small steamers and launches in Banana, and it may be mentioned that in the portion of the river treated there is water enough to float the "Silvertown."

As regards the jealousy of the five or six monopolists who are doing as they like with the river trade, we do not consider the subject worth consideration. What Regis Ainé and Fabre Fils, of Marseilles were on the East Coast before the advent of the cable, so are these gentry now. It is not necessary to say more than that the two great French houses on the East Coast were, three years after the Eastern and South African Telegraph Company completed their system, on a level with a thousand small traders.

ROBEY COMPOUND ENGINE.

We referred in our last issue to the excellent work done by a Robey engine at the late Glasgow Exhibition, and we now illustrate the engine, which, as will be seen, is of the compound horizontal fixed type. There is, we should imagine approaching, a busy age for builders of the best type of engines, especially if there be a general move towards distributing power as well as light. The builders of fast-speed engines must have profited by the extensive adoption of electric lighting by the steamship companies for their passenger ships; and now larger land installations are in progress and contemplation, those who have catered for the smaller installations should keep pushing ahead. The engine illustrated was used to drive some of the dynamos at Glasgow. The cylinders are 18½in. by 30in., with a stroke of 40in. Each cylinder is fitted with the trip-valve gear, the cut-off on the high-pressure cylinder being capable of being varied by the governor from *nil* to three-quarters of the stroke, whilst the cut-off on the low-pressure cylinder is variable by hand while the engine is running. The engines are speeded to give 63 revolutions per minute, and transmit their power from a flywheel, 13ft. diameter, by 12 ropes 1¾in. diameter. Both high and low pressure cylinders have independent steam inlet and exhaust valves. The former consist of double-beat Cornish equilibrium valves fitted to each end of a cylinder, so as to get the shortest possible steam passage, thus enabling the engine to work at all times with an initial pressure nearly approaching that of the boiler; those on the high-pressure cylinder are under the direct influence of the governor. The exhaust valves consist of a special arrangement of Corliss' slide valve, which gives a quick wide opening to the exhaust with a very small travel; they are placed on the under side of the cylinders, so as to efficiently drain the interior, and enable the pistons to work safely with the least possible amount of clearance. They are worked by eccentrics upon the horizontal shaft driving the admission valve gear. The working steam pressure is 100lb. per square inch, and the engines indicate 400 h.p. maximum. Following the action of steam inlet valves, it will be noticed that the valves are lifted and released by trip levers, actuated by eccentrics, driven by a horizontal shaft, rotating at the same speed as the disc shaft, and running parallel with the engine bed. The length of time the trip levers are in contact, and consequent duration of the admission of steam into the cylinder, is regulated by the governor, thus automatically varying the grade of expansion to the work being done. The upper portion of the valve spindle is attached to an air buffer, which, assisted by a spiral spring, suddenly closes the valves when relieved from the trippets. A very precise action of the valve is obtained by this arrangement, and a very sharp cut-off is consequently ensured. To prevent the valves being forced down too suddenly upon their seats, the usual air-cushion is formed and regulated from the outside. This can be adjusted so that while the valves close steam-tight, they yet come upon their seats with checked velocity. The governor regulating the admission valves is one of Richardson's patent spring governors, which, being relieved of all working strain, is so constructed as to give a wide range of cut-off with very slight variations in speed. It is driven by gearing also from the horizontal shaft driving the admission valve gear. The eccentrics are fixed upon a horizontal shaft so as to give a constant lead. The governor is supplemented by a Richardson Nevile electric regulator, which enables the engine to be controlled by the electric

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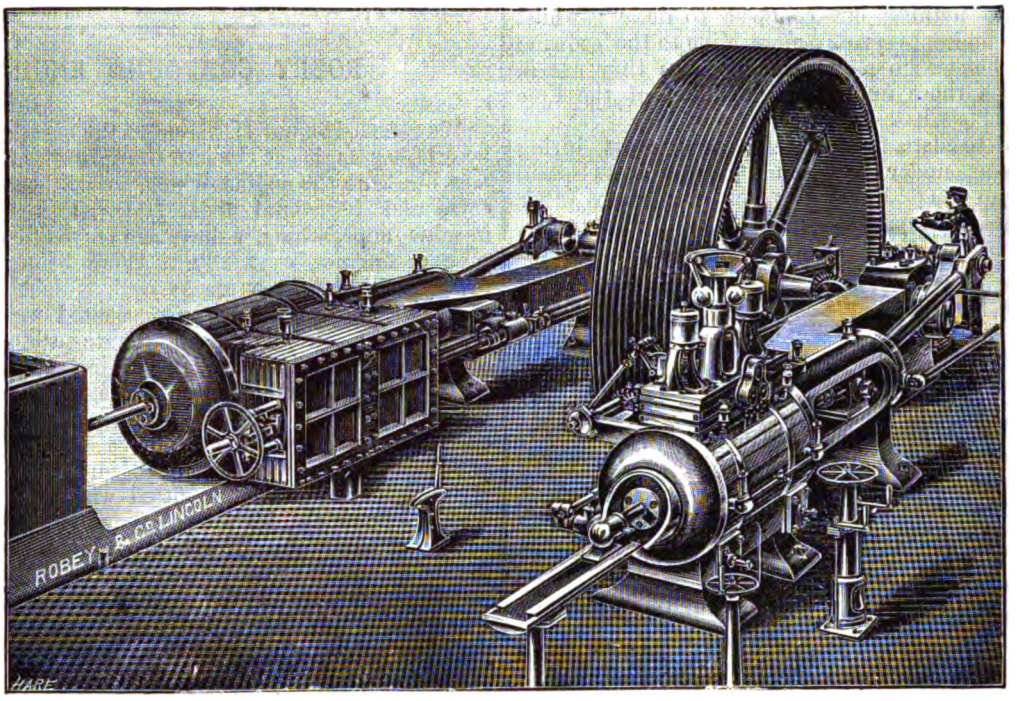
current itself, thus enabling a constant current or constant E M.F. to be maintained with varying loads. The bearings are of large size, made, in three adjustable parts, of Babbit's metal, fitted with sight feed or other lubricators for long continuous running. The steam, in going from the high to the low-pressure cylinder, passes through a super heater, thus raising its temperature. The heating is effected by a coil through which steam from the boiler circulates. Messrs. Robey claim great economy for this type of engine, assisted by the trip gear, and we have no doubt due attention will be paid to it by those engaged in electric lighting.



Robey Compound Fixed Engine.

PHYSICAL SOCIETY. —Nov. 24.

Prof. REINOLD (president) in the chair.

The Rev. T. Pelham Dale and Dr. R. M. Walmesley were elected members of the society.

Captain ABNEY read a paper "*On the Measurement of the Luminosity of Coloured Surfaces*," which was illustrated by experiments. In a communication to the Royal Society, General Festing and the author have described a method of comparing the intensity of the light of different parts of the spectrum, reflected by various pigments, with that reflected from white, and luminosity curves have been constructed, the areas of which give comparative measures of the total luminosities. This method of comparison is accurate, but requires considerable time, and the author has devised a more rapid process. The coloured surface whose luminosity is to be compared with white is placed beside a white patch within a dark box. A direct beam of light passes through an aperture in the box, and a black rod casts a shadow on the coloured patch; another beam from the same source is reflected at an angle, and forms a shadow of the same rod on the white patch, the junction of the two shadows connecting with that of the two surfaces to be compared. In the path of the direct beam is placed a rotating disc with angular openings, adjustable whilst rotating by a simple lever, and by this means the white patch can be made to appear too light and too dark in rapid succession. By gradually diminishing the range of oscillation of the lever, a position of equal low luminosities can be found. The coloured surface is now replaced by a white one, and the adjustment again made, and from the angular apertures required in the two cases the relative luminosities are determined. Comparisons made in this way (the numbers relating to which are given in the paper) with emerald green, vermillion, French ultramarine, etc., gave results in close agreement with those deduced from the luminosity curves obtained by the spectrum method.

In reply to questions, Captain Abney said the spectrum method was the more accurate, and could be relied on to 1 per cent. The new method gave results within 2 per cent., showing that the eye is very sensitive to small changes of luminosity when such changes take place in rapid succession.

Prof. RUCKER made a communication "*On the Suppressed Dimensions of Physical Quantities.*" In arranging a system of dimensional equations for thermal quantities, the question arises as to what are the dimensions of temperature. A degree of temperature, as measured by the ordinary arbitrary method of the mercurial thermometer, is not affected by changes in the units of length, mass, and time, but the numerical values of thermal quantities (J, for instance) depends on the scale of temperature adopted—say, Centigrade or Fahrenheit. Two courses seem open, either of which renders a complete system of thermal dimensional equations possible: (1) Temperature may be considered as a measure of energy, as in the kinetic theory of gases, and may be expressed as the energy of translation of a standard number of molecules—say, that number contained in 1cc. of air at standard pressure and temperature; or (2) temperature may be considered as a secondary fundamental unit. If the first be adopted, the dimensions of specific heat become M^{-1}, and the temperature of 0deg. C. is expressed by $1{\cdot}5207 \times 10^6$ ergs. If a practical unit corresponding to $\frac{10^5}{18}$ ergs be adopted, this new unit of temperature will coincide with the centigrade degree to about 1 part in 3,000. The chief objection to such a definition of temperature is, that the above relation between temperature and energy is not yet proved to hold for liquids and solids. If the second course be adopted, the dimensions of all thermal quantities may be expressed in terms of M, L, T, and θ, where θ is the unit of temperature. Attention was directed to the difficulties students generally experience on finding the dimensions of the same electrical quantities to be different, according as they are expressed in electrostatic or electromagnetic measure, and that different quantities may have the same dimensions. The anomalies are shown to be due to the suppression of the dimensions of specific inductive capacity and permeability, each being called unity in air. By retaining K and μ in the dimensional equations the author thinks that many difficulties will be avoided, the methods of transformation of units will be generalised, and the limits of our knowledge kept more clearly in view. Though the dimensions of K and μ cannot be determined, it is easily shown that those of the product $K_1 \mu_1$ are $L^{-1}T$.

Mr. BLAKESLEY, in commenting on thermal units, strongly protested against the use of the word "therm" as

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a name for the unit of heat. If used at all, it should be reserved for the unit of temperature. Referring to the choice of fundamental units, he reminded the society that the dimensions of quantities expressed in the electrostatic or electromagnetic systems become identical if the unit of velocity be the velocity of light, and by choosing the unit of time as a suitable decimal part of a day, the relations between electrical and practical mechanical units could be simplified.

Prof. CAREY FOSTER, after discussing the effects of defining specific heat as a ratio, or as a quantity of heat on the dimensions of temperature, pointed out that as quantity of heat = temperature × entropy, the dimensions of temperature would be determinate if those of entropy were found.

Prof. S. P. THOMPSON considered part of the difficulties of dimensional equations arose from the fact that no distinction was made between *scalar* and *vector* quantities. Thus the dimensions of work and moment of a force are given as $M L^2 T^{-2}$, whereas the true representa ion for the latter would be $M L^2 T^{-2} \sqrt{-1}$, because the line by which the force is multiplied is at right angles to the force. By similar considerations Ampere's rule for the force between two current elements can be derived from the magnetic equation $\frac{m.m^1}{r^2} = f$, for replacing m and m^1 by equivalent current elements $i \,.\, ds$, and $i \,.\, ds^1$, the equation becomes

$$f = \frac{\sqrt{-1}\, i \,.\, ds \,.\, \sqrt{-1}\, i \,.\, ds^1}{r^2} = \frac{-i^2\, ds \,.\, ds^1}{r^2}$$

Referring to the use of *therm*, Dr. Thompson concurred with the remarks of Mr. Blakesley, and thought the word *calorie* answered all requirements. He also considered that thermal equations were greatly simplified by always expressing specific heat in ergs.

Prof. AYRTON was of opinion that students experienced much greater difficulty in dealing with electrical units than with thermal ones, and thought part of this was due to the vague way in which some of the standard text-books treated the subject. With reference to the force exerted by quantities of electricity, Prof. Perry and himself had pointed out that specific inductive capacity must be taken into account, for, contrary to Faraday, they had found it to be different in different gases.

In reply, Prof. RUCKER said he often explained the identity of the dimensions of work and moment of a force, by considering moment as measured by the work done in rotating through unit angle, the dimensions of angle being zero as regards L, M, and T. He also pointed out that in Bayne's thermodynamo specific heats are always expressed in ergs.

In thanking Prof. Rücker for his interesting paper, the PRESIDENT expressed his conviction that by paying attention to the points considered, the difficulties arising from the two systems of units would be considerably diminished.

ELECTRIC TRAMWAYS.

(Concluded from page 432.)

Mr. ROBERT W. BLACKWELL, of the Bentley-Knight Electric Railway Company: A year ago I had the pleasure of addressing you at the Philadelphia meeting. I spoke of a good many things then that we would do during the year to come, and we have fulfilled most of them. We were at that time about to run the road at Allegheny city, a little over a mile in conduit and about three miles overhead. We have run that road now with two cars since the middle of December. Since the middle of February we have run four cars, and for the last six weeks we have run six cars. That road is doing to-day, I think, the heaviest work done anywhere in the world by electrical motive-power. Of the entire length of the road, 60 per cent. is in curve, and there is a total rise of 295ft. in 4,900ft., the steepest grade being 12½ per cent. We are using exceptionally powerful motors—the heaviest in the country, there being 30 nominal h.p. on every car, and each pair of motors develop at times 75 h.p. The road, I think, is subject to the worst conditions of any road in the country. After a storm the water comes running down like a freshet through the side roads and rushes into the conduit; the mud is phenomenal, the pavement is bad, but there has never been a stoppage caused by any defect in motor mechanism or conduit construction. While the road was still in the constructors' hands a fire in the car-house destroyed half of the cars, and in consequence the road was not deliverable until the early part of June. Since that time the road has been operated by the Observatory Hill Passenger Railway Company. As to expense, I would briefly say that the entire operating cost of the road, including interest upon the investment, is under 65dols. per day. While I was last in Allegheny the receipts of the line were as follows: September 23, 201dols.; September 24, 116dols.; September 25, 151dols.; September 26, 153dols. During this period only five cars were in operation, some alterations in the power station rendering it impossible to get power for all six cars. The average daily mileage of each car was 85 miles. During the four weeks while the road was being operated by the railway company on trial, preparatory to its being accepted from us as contractors, the expense and receipts for four cars (the original number ordered) were as follows:

Week ending.	Expense.	Receipts.
May 12	$232.64	$453.60
,, 19	227.59	443.90
,, 26	245.77	527.90
June 2	213.99	664.40

The two succeeding weeks were as follows:

June 9	240.99	600.70
,, 16	283.91	601.00

The fact that a number of men were, during these weeks, working on the road-bed, accounts for the difference in the expense column for these weeks.

During the above period the average mileage per car per day was 75 miles.

During the time that we have been working on this road, we have met every possible difficulty, and have met it successfully. The grades and curves are, I think, greater than those anywhere yet operated by a self-propelled motor without aids to traction.

The specialty to which the Bentley-Knight Company desires to call your attention is the conduit system.

We have laid the only conduits ever worked successfully, and our desire is to introduce the conduit form of construction upon city roads. Of course, we put up elevated conductors as well, and build roads partially overhead and partially conduit. We have successfully met every difficulty from insufficient drainage, floods, mud, crossings of other roads, switches, turnouts, excessive loads, and the like. I think it is fair to say that the conduit line at Allegheny city, although short, is a practical solution of the question of adaptability of electrics to city railway service. We are now laying, as Mr. Sprague has just informed you, a three-mile section for the West End Street Railway Company, of Boston. Over that conduit, a section of which we have here for your inspection, will be operated motors supplied by several companies; and upon that road, both the conduit and overhead systems will, I think, receive the best and most thorough test that has ever been made of electrics in their applications to city street railway service. These cars will be run in competition, undoubtedly, and will be forced to run against each other, both on the overhead and underground systems. The result of that trial will, I think, decide the future. There can probably be no more thoroughly fair and square test than that afforded by the West End Company.

The cost of conduit ranges from 15,000 to 30,000dols. per track mile—taking into consideration average cost of drainage and average difficulties—the smaller figure applying to our lesser and the larger to our greater cities, the difference being largely caused by the cost of providing against the strain to which the conduit will be exposed from traffic over the slot, and climatic changes.

We do not object to the overhead system wherever the municipal authorities will tolerate the placing of a network of suspended wires. As the cost of elevated conductors should not exceed—at most—3,000 dols. per double mile of track, that system can be advantageously laid where the cost of conduit would preclude its adoption. As is now done at Allegheny city, elevated wires in the suburbs are a most effective supplement to a conduit system in the paved and sewered streets of a city. The tendency to the cheapest forms of construction where suspended wires are used is, however, to be greatly deprecated, and much trouble and uncertainty of operation has been caused by the employment of the cheapest design, material, and labour to the general damage of electrics in the eyes of practical men.

I have not mentioned our dynamos, motors, and mechanical constructions as applied to the equipment of the cars themselves. All that is good, reliable, and efficient is claimed by every electric man for his own particular plant. What has been said by the other gentlemen applies therefore to what my company furnishes. We, as well as the others, have the best of everything, and in support of that statement refer to what we are now doing and to the work laid out for us in the coming year. During the coming winter there will be, not only in Boston, but in Allegheny, and possibly in New York, a

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thoroughly good, careful test of exactly how an electrical conduit system will work during the winter months; and in each place where it is to be constructed the difficulties are such that their solution will meet the requirements of every road there is in the United States.

Mr. RICHARDSON, of Brooklyn: Where will the conduit system be seen in New York?

Mr. BLACKWELL: During the last week arrangements have been entered into between the company that has been trying to put a road through Fulton-street, New York, and the opposing company, and at last an agreement has been signed, as I understand, which places the Fulton-street line in a position where it can construct half of its road from Broadway to Fulton Ferry at once. I will say that the material for that line was prepared a year ago, and we have endeavoured constantly to get the matter in some position where the road could be built. We understand now that half of the line can be built before the middle of November. The cars will probably not be delivered till the month following.

In closing, I would say that there are many motors to-day offered to you by many companies, and that in selecting an electrical machine, the same care, scientific and mechanical, should be taken as is taken in the selection of any other machine for the application of power.

Price is a poor criterion, the cheapest is rarely the best; and, furthermore the extraordinary attempts now made by the electric companies to underbid each other and get work on whatever terms, lead to all kinds of disastrous results, not only to the seller, but to the buyer as well.

There is another fact that we have to meet, and that is, that while the electric motor car takes the place not only of the present car but of the horses as well, it only gets the care that is now given to the car, and none of the care that is given to the horses. Now, you cannot expect a mechanical thing to run well and successfully unless it is well taken care of, and unless the same care and attention is given to it as is given to other machinery. Somebody must take care of all mechanical things; somebody must keep the mechanism in good and proper shape, and unless so kept up, it will be a dismal failure.

Mr. THOMAS C. BARR, president of the People's Passenger Railway Company, Philadelphia: I desire to state for the benefit of the gentlemen present, on the storage battery question, that we experimented with a car so operated on our road over about four miles of track for at least two months. The car was run 16 miles a day; it was erated in the afternoon. It was a 22ft. car, weighing in the aggregate, trucks, batteries, car and all, 14,800lb., of which 4,800lb. was the weight of the batteries. This car was operated and managed by the Electric Car Company of America. In order to get the best results, and as we anticipated introducing electricity as a motive-power on our line, it was necessary to give the experiment a full opportunity for success, to relay our line, which we constructed with girder-rail, crossties every 2½ft.—a construction that would practically carry from 15 tons to 20 tons weight. The car would seat 34 passengers, and would carry crowded 125, so that the aggregate weight when the car was crowded would be in the neighbourhood of 30,000lb., possibly more. As I said, we ran the car two months, and it was very satisfactory. The car ran smoothly and nicely; and it moved off gently and firmly after a stop without any jerky movement of any kind that would be noticed by any of the passengers. The car was taken off only by reason of the fact that a large sewer was being constructed through the central part of our street, causing us to run over a siding, and we were afraid the weight of car would interfere with the work.

As to the cost of operating that car, we cannot give that to you satisfactorily, by reason of the fact that the power for charging the batteries was leased at a high figure. It took three and a-half hours to charge a battery which operated the car for 16 miles. We would roughly estimate it at possibly a cost of 50 or 60 cents for the 16 miles, taking 80 miles as the day's work for the car; with 18 hours' work for our men, it would make the cost of operating that car for a day in the neighbourhood of 9dols.; but I presume we could reduce that materially by operating our whole line with electric cars. The 9dols. would, of course, include the wages of our men, as well as the cost of charging the batteries. We found that the car ran so smoothly that a high rate of speed could be attained and not be noticed by those on the street or by passengers. This car was operated on a level, there being no grades on our road. We had, of course, some four curves at the terminus of the road which the car ran around without any difficulty at all. The same car was operated in the works of the electrical company with one charge some 63 miles. This, of course, was very satisfactory when you take into consideration the character of the car, weighing, as it does, some 15,000lb. In operating the car over your road, where it is necessary to stop at almost every crossing, you will find that the power necessary to start that car at every crossing is wasted to a great extent; in other words, you can operate the car over a level, without stops, at practically about 10 or 15 per cent. expenditure of your power, but when you come to each crossing, and have to stop and start continually, the expenditure of your power will run up in the neighbourhood of 80 or 90 per cent. This not only wastes the power, but causes a great strain on your motors as well. Taking it in all, the experiment was very satisfactory as far as the operation of the car was concerned. We have looked into the matter very thoroughly, and have determined that in order to operate a street railway line with electricity, it is necessary to have each car separate and independent of the others in order to get the best results. We have devoted our attention to the storage or secondary battery system. We are waiting until such developments are made that the system is brought down to such a point that it will be financially practicable to equip our line. The only difficulty that stands in the way at present is the actual cost of the cars with the storage battery cells and the cost of constructing the road; and I have no doubt that in a very short time this system will be brought down to such a point that a car much less in weight can be operated by a battery, so that the cars can be operated over our present construction, thereby saving that expense, and also save the expense of the storage batteries, which, unfortunately, are controlled by companies which ask a royalty or percentage, and which makes the cost so high that it practically makes your car cost more than you want to put into a plant of that kind. I can say to the gentlemen of the convention that I think the day is not far distant when the storage battery will be a thing of the past, and the primary battery will be in practical operation, reducing the weight one-third and the cost proportionately, and thus enable us to run our cars without reconstruction of the roads and at less expense. I will be pleased to give any gentleman information who may ask me if I can.

Mr. GEO. W. MANSFIELD, of the Thomson-Houston Electric Company: Mr. President and gentlemen of the association—I know that it is rapidly approaching the hungry man's dinner-hour; and I think that the merits of the Thomson-Houston system in incandescent and arc lighting, stationary motors and the new railway line are so well appreciated and being so thoroughly recognised by all, that any lengthy remarks that I might make here would be unnecessary. I would, however, like to state one or two facts, one or two matters which I think would be of interest, and that is, first and foremost, that we invite the most accurate and minute inspection of all the street railway men at this gathering or in this country to our system. There is nothing covered up, there is nothing to be hidden, and there is no secret about it which we not want you all to possess. We clearly recognise that to have our system adopted by the street railway men they must first know about it, and they can only know by thoroughly investigating and knowing all that is possible to learn. For my part, I should prefer to have every street railway manager or superintendent an electrician; and I agree with Mr. Blackwell in his remarks that the electrical motor, as a mechanical construction, must have care and supervision, and must have intelligent inspection. They cannot run covered with slime and grease; they cannot run where moisture is prevalent, and where the rain is going to beat down upon them and flood them; and they cannot run under a great many other circumstances which many street railway men suppose they can run under. We have here in Washington, running from Seventh-street out to the boundary line and then beyond to Eckington, about two miles of road. Upon that road is exemplified most of the details of our system, our truck, with its mode of suspension of the motor, this motor being one with the truck and suspended from the car, the form of the motor, the form of the gearing, the contact, the armature, the brush-holder and the brushes themselves, and the manner of controlling and covering the motors, all of which are pertinent points that everyone of you gentlemen must familiarise yourself with before you can intelligently select an electric motor for your roads. Upon this road you will see two cars running. We did not intend originally to hurry the line through so rapidly, but to take proper time and adjust everything carefully, but due to solicitations we have pushed matters, and now, as I say, we have two cars in operation on the line.

Regarding the overhead work—and it is entirely constructed with the overhead system—I would say that the three methods most generally in use are there shown. One method which exists there has not been applied in any other city in the United States, to my knowledge, and one that is destined to take a prominent position in the construction of overhead lines in large cities, and that is the location of the poles in the centre of the street, it being a two-track system. New York-avenue is broad, and therefore this method is permissible. Along through a cut just beyond the boundary is what we call the "bracket method"; that is, one pole over the side of the street, and arms extending from that pole. Further out is what we call the cross-suspension. In this method the poles are upon both sides of the street, with the wires reaching across. If you give this road your careful inspection, you will see there these three methods exemplified. We would like to call your attention to our commutators and our cone insulators; also to our attachment of the car to the top of the conductor, so that it allows a perfectly smooth and free surface of the under side of the wire for

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the trolly-wheels to roll upon. We would like to call your attention to our tracks for cross-overs and our curve tracks.

I note that the electricians and electrical constructors of different companies are sometimes prone to offer apologies and excuses, and say we are not quite ready and have not got everything done; but we are going to do such and such a thing, and are going to do this and that. We have done in the limited time which the United States Senate would allow to us, we feel, a fairly creditable amount of work. This line, it must be remembered, was put up under some opposition. There was a law framed by the District Commissioners that no more wires should be put up after a certain day. This law bothered us a good deal, and we have had to push around very lively to get our overhead work up before the expiration of this date. But we succeeded in accomplishing our object, and two cars are now running, and we invite your careful inspection of the same. Before taking my seat, I would like to ask one other favour of the street railway men; and that is, that the electricians do not know to-day all there is to be known in regard to street railway management and street railway requirements; and, on our side of the house, we would like to ask a question of you; we would like to have your hearty co-operation; we would like to hear from you every time we can. In that way the Thomson-Houston Company feel that they can build what you require, and will construct apparatus that will meet your wants quicker and better than to go along thinking that they know it all, and that they can manage a street railway as well as you. Trusting that we shall have the pleasure of seeing you at the road this afternoon, I will take my seat, unless there is some question that you would like to ask in regard to the Thomson-Houston system.

Mr. SINCLAIR, of Galveston: I would like to hear from the gentleman in regard to the relative danger or safety of the system, in regard to accidents to passengers. I ask that question for the reason that I believe that was the Van Depoele system originally.

Mr. MANSFIELD: The single connection of our system, as put forth to-day, with the Van Depoele system is that the Thomson-Houston Company purchased all Mr. Van Depoele's electric railway patents, and they have the service of that ingenious and practical man. While the system which we put forward embodies a great many of his ingenious points and ideas, and which are protected by his patents, yet the motors, the method of suspension, and a great deal of the other work is done purely and entirely on the Thomson-Houston system and principles.

Mr. SINCLAIR: I ask the question for this reason: I am told that the road at Montgomery, Alabama, has had a number of serious accidents resulting from the electrical conductors.

Mr. MANSFIELD: That road was built by Mr. Van Depoele before the Thomson-Houston Company decided to go into the field. They have absolutely no connection with the road, and the question of danger cannot be thrown upon their system any more than on any other. I presume the only danger you had reference to was the liability of the construction wire to fall or roll off, or something of that kind; or possibly the question of shocks from the potential used in a very heavy conductor. The potential which we have used varies. In some instances it is 400, and in some cases 600 volts. It usually averages about 450. That question was very carefully considered, and gone into in detail by the committee appointed by the United States Senate, and that committee decided that the Thomson-Houston system was not dangerous at all, and therefore granted the permit to put it up. In regard to the only accident which I have ever heard of, personally, occurring at Montgomery, I believe it was caused by the falling of some wire, telegraph wire, or something of that kind, which came in contact with the overhead wire of the railway, and then a portion of it fell to the ground; and some man drove his horse upon the wire, and the horse received a shock. But we protect our wires by means of guard rails, so that any falling wire cannot touch the conductor; and our methods of construction are so well known and are so practical, that no one need have any accident. The Thomson-Houston Company means to do what is right and safe.

BRITISH ASSOCIATION, BATH.*

ON THE ELECTROLYSIS OF THALLIUM TRISULPHIDE.

BY J. H. GLADSTONE, PH.D., F.R.S., AND WALTER HIBBERT, F.I.C.

In a communication made to the committee in the early part of this year we gave the results of some experiments on the electrolysis of solid sulphides. It was pointed out that the sulphides electrolysed up to that time—silver and cuprous sulphides—were of analogous constitution, containing two atoms of metal to one of sulphur. Led by this circumstance, we succeeded in getting electrolysis of another similar compound—thallious sulphide, Tl_2S.

Some of our early experiments happened to be made with a compound containing more sulphur than that required by the formula Tl_2S, and this suggested an attempt to electrolyse the compound of thallium and sulphur which has the formula Tl_2S_3. This compound is soft and plastic at the temperature of a warm summer day, and might reasonably be expected to show electrolysis.

We found some difficulty in preparing the compound by the method given—*i.e.*, by fusing thallium with excess of sulphur, and driving off the excess at a very high temperature. It was much easier to obtain it by first making some pure Tl_2S, and then gently heating this with the theoretical amount of finely-divided sulphur. At about the melting point of sulphur (120deg. C.) combination ensues, and at a slightly higher temperature appears complete. Thus prepared, Tl_2S_3 is a dark grey compound, behaving like an extremely viscous body. Under comparatively slight pressure, and at ordinary summer temperatures, it can be easily bent and moulded.

In testing whether this compound could be electrolysed, we enclosed a little of it in a glass tube and then pressed a metallic electrode into contact with it at each end. Sometimes these electrodes were made of silver, but in most of the experiments they were of platinum.

Three Grove's cells were employed. The resistance of the trisulphide was very high, and the deflection, even when using a high-resistance Thomson reflecting galvanometer, was generally small. At 12deg. C. the current was very weak, but it showed a tendency to increase if the battery was left on for an hour or two. The polarisation was not detectable with such a small current. At temperatures ranging from 20deg. to 40deg. or 50deg. C. the current increases, and polarisation becomes evident. The values obtained for the polarisation E.M.F. vary so much with the temperature and the duration of electrolising current that only an approximation can be stated. Generally speaking, the polarisation E.M.F. increased with the electrolising current, and reached in some cases a value somewhat over half a volt. In one case a potentiometer measurement indicated approximately 0·8 volt.

It was observed, after all the experiments, that the pellet of trisulphide was no longer plastic, but had become hard and brittle. As this might be indicative of a change in composition, a little of the sulphide, simply enclosed in a glass tube, was sometimes placed in the water oven along with the specimen undergoing electrolysis. At the close the two specimens presented about the same degree of hardness and brittleness; and we therefore concluded that the trisulphide is subject to a molecular change through heat, independent of any effect due to electrolysis.

The effect of the molecular change was evident during the experiments. After an hour or so of heating the current would begin to diminish and fall towards zero. The diminution was probably caused by an increase in the resistance of the trisulphide, seeing that the polarisation E.M.F. was little altered so long as it could be measured. It was this phenomenon that generally brought the experiments to a close.

We thought this increased resistance might be due to a decomposition of the compound Tl_2S_3 at the temperature employed (30deg.–50deg.), accompanied by a separation of sulphur. On trying, however, to obtain evidence of such separation, by treating the specimens with carbon bisulphide, we quite failed. Only a trace of sulphur was separated, and the quantity was practically the same from both the original and the changed specimens.

The alteration in properties, which we have supposed to be due to a molecular change, has a considerable bearing on the interpretation of the results; for in its plastic form the trisulphide can hardly be looked upon as a solid comparable with the cuprous, argentic, and thallious sulphides. In the hard and brittle form it can hardly be classed as a conductor. Thus our previous conclusion is not invalidated by it.

* Communicated by the Secretary of the Electrolysis Committee.

CHELSEA.

The directors of the Chelsea Supply Company have addressed the following memorial to the chairman and members of the Vestry of Chelsea:

The London Electric Supply Corporation has, it is understood, applied to the Chelsea Vestry for a way-leave to lay down underground mains for electric lighting in Pavilion-road, Chelsea. It is also understood that the Electric Lighting Committee's report on the subject will be considered at any early meeting of the vestry.

In view of the important effect of the results of such consideration on the undertaking of the memorialists, they have the honour to submit the following statement:

Your memorialists, who are the undertakers under the Chelsea Electric Lighting Order Confirmation Act, 1886, 50 Vict., ch. xviii., are at present at work in laying down their electric light mains, in the area of supply scheduled as A in the order, and have contracted with Messrs. Callender's Bitumen, Telegraph, and Waterproof Company, the well-known cable makers, to carry out the said work in the shortest possible time. The largest portion of Pavilion-road is included in that area. It traverses the centre of the district.

In this work they are acting under the obligations which their order imposes, including a liability of forfeiture of the deposit of £2,000, which they have lodged with the Board of Trade under its terms. Before commencing work they had to comply with all the formalities prescribed by the Act, and in future they will be obliged to work and supply electricity under all the regulations, penalties, and conditions imposed by the same. The London Electric Supply Corporation are endeavouring to enter the A district allotted to your memorialists without incurring any of these obligations, and without suffering the necessary delay in having to fulfil them.

The generating station of your memorialists, in progress of construction, is within the parish, at the south end of Pavilion-road. The London Electric Supply Corporation's present station in Bond-street, and future station at Deptford, are both outside the parish, and

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therefore beyond the legal hold of the vestry in the matter of control now, and ultimate purchase.

The present system of that company, known as "high tension" and "alternating" direct supply, is thought to be of such electric tension as to be dangerous to life. This system has not received the approval of the Board of Trade, which is obligatory to all who work under provisional orders.

The policy of the London Electric Supply Corporation is foreshadowed by the advertisements in the daily papers of the 20th inst. of their statutory notices, which include nearly every parish in London.

They have rapidly extended their conducting mains from Bond-street to several parts of London by means of the overhead cables, to be seen in many parts of the town; and the permission now sought by them from the Vestry of Chelsea is a movement in the same direction, by which they may obtain a footing within the boundaries of the areas dealt with under the Chelsea Electric Lighting Order, obtained in September, 1886, by your memorialists, the only order at present in operation.

The memorialists believe that this policy points to the establishment of a huge monopoly, by either absorbing or smothering all the local companies that may stand in its way.

The houses in Chelsea have been wired by various contractors, not by the London Electric Supply Corporation, which does not do such work.

They may have induced residents to have their houses wired, and promised to supply them with current; if so, they have done it with the full knowledge of the position of your memorialists, and of the work of canvassing which has been carried on for the last two years. They now attempt to reap the fruit of the work of your memorialists. In travelling all the way from Bond-street to reach Chelsea, they pass hundreds of houses in Mayfair and Belgravia, where no provisional orders are in operation. All the rest of London is open to them, with houses also everywhere waiting for current.

It may not be out of place to mention that lately, when your memorialists applied for the support of the St. George's Vestry towards their obtaining powers in a portion of that parish (Belgravia) close to their central station in Chelsea, that body rejected the application, although no provisional order is in force in St. George's parish, and the field was presumably open to all comers. On the other hand, every encouragement was given to the London Electric Supply Corporation. Your memorialists naturally deprecate the vestry giving encouragement to the proposed encroachment in Chelsea to their injury.

Your memorialists are by Act of Parliament subject to the authority of the vestry. At present, other companies are not similarly responsible. It may be a doubtful point at law how far the vestry have authority to enter into a special agreement to take up the roads for the distribution of electricity to private consumers with a company not working under a provisional order. Your memorialists are advised by high legal opinion that it is *ultra vires*.

Your memorialists have been taken by surprise, as they have received no warning from the vestry of its intention to establish competition without the intervention of the Board of Trade, which under the Electric Lighting Act alone has power to grant orders.

However this may be, they trust that the vestry will decline to sanction a proceeding which your memorialists conceive to be unfair to them, and injurious so far as the future of electric lighting in the parish is concerned, at any rate so long as they are acting *bona fide* to their obligations.

The following is a short statement of the history and status of your memorialists, the Chelsea Electricity Supply Company:—

In 1885 the necessary notice was given to the vestry, and the draft provisional order was drawn up. After some discussion with the vestry on the details of the order, the draft was deposited with the Board of Trade on December 19, 1885. The Act confirming the order was passed through Parliament on September 25, 1886.

The objectionable selling clause of the Electric Lighting Act, 1882, allowing the local authority to buy up the company's electrical station and plant for the price of old material at the end of 21 years still remained in force, and the Chelsea Company was told by financial advisers that so long as this was the case there was no chance of obtaining the required capital.

On that account they approached the Board of Trade and the vestry early in 1887, with a view to obtaining an extension of time, and, finally in June in that year obtained the consent of both bodies to the suspension of the operation of the compulsory clause until September, 1889.

Nevertheless, in order to fulfil their arrangements with the vestry, they published the prospectus of the company in July, 1887, and called a meeting of the inhabitants, but failed to induce more than a few to subscribe.

On the passing of the Electric Lighting Act, 1888, they laid their position before eminent electrical manufacturing firms, who, perceiving the value of their undertaking decided to take up and float the company on a sound engineering and commercial basis. Consequent upon this, they again brought their company before the public in July, 1888, and obtained the necessary capital. Contracts were at the same time entered into with these companies for the laying of mains and supplying plant, and plans of the building for the generating station were got out. There has been some delay in getting these approved and in other matters, owing to the time of year, August and September, when so many people were away from town. All these preliminaries were, however, completed in October, and received the approval of the Chelsea Vestry. Contracts to the value of £27,000 have been made.

On the 29th September the deposit of £2,000, under the Act, was made with the Board of Trade, and a copy of the acknowledgment of the deposit was handed to the vestry on the 3rd October.

The unavoidable difficulties causing delay, as detailed above, have been all overcome, and the Chelsea Company are now proceeding as rapidly as possible with the work. The building and the laying of mains are in progress, and they are now proceeding with the rest of the work required for distribution of electricity to every house in the A district of the order.

COMPANIES' MEETINGS.

EASTERN TELEGRAPH COMPANY.

An extraordinary general meeting of the Eastern Telegraph Company, Limited, was held on Thursday in last week at Winchester House, Old Broad-street, Sir J. Pender in the chair, to consider a resolution increasing the ordinary share capital of the Company to £4,000,000 by the creation and issue of 20,000 new shares of £10 each.

The **Chairman** stated that at the time of the amalgamation in 1872 the Company owned 8,862 miles of cable, and owned and rented 1,200 miles of land lines. They then had 24 stations and two cable repairing ships. The capital was £3,397,000, and the gross revenue was about £376,922 per annum. In March last their capital was £5,900,000, the gross annual revenue was £650,971, they had 22,405 miles of cable, and with the Eastern and South African Company's existing cables and the extension to Loando, the total would be 29,108 miles. They had now 64 stations and agencies, and they had added three new ships to their fleet. The increase in the capital since the amalgamation had been £2,503,000, and, in addition, over £700,000 had been applied from the reserve fund, and a new ship, costing over £45,000, had been paid for out of the ships' fund. Of the increased capital £1,200,000 now bore only 4 per cent. Having given a detailed statement of the work which had been done since 1872 in building up and strengthening the Company's system, he observed that the immense progress made by them in the last 16 years had been largely facilitated by their having kept ahead of the requirements of the public. The increase in the capital now proposed was to duplicate the South African system, which they took in hand in 1879, and by that proceeding they would still further secure the interests of the Company and give greater permanency to the system, which was of essential importance to the telegraphing public. A good deal of doubt was felt in 1879 as to the propriety of the Eastern Company taking the whole responsibility of the South African system, and the risk was therefore shared by other companies. For all practical purposes, however, the control of those companies was in the hands of the Eastern Company. Owing to the increase in the traffic, it was now absolutely necessary to provide additional accommodation; but instead of duplicating the system by which they at present approached the Cape—namely, by the east coast—it had been decided to carry a line by the west coast. By laying that new line in connection with the existing systems, they would have an alternative line from London direct to the Cape. The increase of £200,000 in the share capital would be expended in purchasing shares which the South African Company were going to issue; and the other £300,000 which would be required for laying the new cable would be in debentures, which would be issued to the shareholders *pro rata*. By the proposals now before the meeting they would eventually find themselves in possession, for comparatively a nominal sum, of the vast cable system to South Africa. After speaking of the importance of concentrated management in regard to cables, he concluded by moving a resolution authorising the issue of 20,000 new shares of £10, to be offered first to the shareholders at a premium of £2 each, the premium to be added to the general reserve fund—"holders of from 10 to 20 ordinary shares to be entitled to one new share, and holders of more than 20 ordinary shares to be entitled to one new share for every complete 20 ordinary shares held."

The **Marquis of Tweeddale** seconded the motion.

In answer to questions, the **Chairman** stated that the £300,000 of debentures would be issued at par. After allotting the shares as proposed in the resolution, 1,900 shares would remain in their hands, and those shares would be offered to the smaller shareholders—the holders of less than 10 shares.

The resolution was carried unanimously.

THE PILSEN-JOEL AND GENERAL ELECTRIC LIGHT COMPANY.

The seventh ordinary general meeting of this Company was held on Friday last at the City Terminus Hotel.

Sir R. W. Rawson, who presided, reminded the shareholders that the Directors expressed their views last March with respect to the future operations of the Company. Those views, however, were not supported by a sufficiently large body of the shareholders, and the Directors were reappointed with instructions to make provision for the sale of the business. An offer was made, but obstacles were thrown in the way of its acceptance, and some of the shareholders thought that if a limited time were allowed, an opportunity might be presented of obtaining more favourable terms from some other purchaser. No other offer had, however, been received, and the time had now come for some definite step to be taken. Two communications had been received by the Board—one from Mr. Roper, stating that he should propose a resolution for the voluntary winding up of the Company, and the other from Mr. Fellowes, who had commented on the transactions of the Company during the year, and said he thought it was for the Directors to state their views. He had already reminded them that the Board expressed their views at the meeting last March. He concluded by moving the adoption of the report and accounts.

Mr. H. W. Scriven seconded the motion.

In the discussion which followed, further information was asked by **Mr. George Hopkins** with respect to the accounts. The opinion was expressed by some speakers that the Company might be carried on

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profitably with additional capital; but other shareholders considered that, in view of the dissensions which existed, the most advisable course would be to wind up; and **Mr. Quilter, M.P.**, who stated that he represented several large shareholders, intimated that unless a voluntary liquidation were decided on at the meeting he would take steps for securing a compulsory winding up.

Mr. Scriven, in reply to **Mr. Hopkins**, stated that during the year ended last June they had called up £3,069 more capital, they had increased their liabilities by £739, and their cash had diminished by £2,063. On the other hand, they had increased their stock by £3,805, and their book debts by £666.

The motion was adopted, and the retiring Director and Auditors were re-elected.

After further discussion a resolution was passed recommending the Directors to take the necessary steps for the voluntary liquidation of the Company.

NEW COMPANIES REGISTERED.

Mining and General Electric Lamp Company, Limited.—Registered by Paine, Son and Pollock, 14, St. Helens place, E.C., with a capital of £100,000, in shares of £1 each. Object: to adopt and carry into effect an agreement dated November 24, 1888, and made between the New Portable Electric Lamp and Power Syndicate Company, Limited, of the one part, and this Company of the other part, to acquire certain letters patent regarding the use of electricity in safety lamps for mining and other purposes. The first subscribers are:

	Shares.
F. H. Sumner, 17, Queen Anne's-gate, Westminster	1
B. Nicholson, The Torrs, South Norwood-park, S.E.	1
J. Wood, 16, Matham-grove, East Dulwich, S.E.	1
H. W. Roach, 33, Warlingham-road, Goose Green, S.E.	1
G. C. Holman, 104, Fort road, Bermondsey	1
E. W. Francis, 38, Kimberley-road, Clapham Rise, S.W.	1
H. A., 90, Royal-road, Kennington Park, S.E.	1

There shall not be less than three nor more than seven Directors of the Company. Each Director shall hold not less than 500 shares in the Company. The first Directors shall be the Right Hon. the Earl of Crawford, A. Storey-Maskelyne, M.P., the Hon. Reginald Brougham, James G. Stephen, Dr. Frautland and Dellwyn Parish, M. Parish. The Directors by way of remuneration for their services, shall be paid out of the funds of the Company the sum of £2,000 per annum.

Windsor and Eton Electric Light Company, Limited.—Registered by Sydney Morse, 7, Fenchurch-avenue, E.C., with a capital of £30,000, divided into shares of £1 each, 50 being founders' shares. Object: to carry on the business of electric engineers, electricians, engineers and contractors, manufacturers of electrical apparatus, and mechanical and chemical engineers, and of producing light, heat, sound and power by electricity, galvanism, or magnetism. The first subscribers are:

	Shares.
Major-General C. E. Webber, 17, Egerton-gardens, S.W.	1
E. S. Churchill, Castlemead, Windsor	1
A. Shipley, Datchet	1
A. W. Shipley, River Bank, Datchet	1
A. Fox, 49, High-street, Windsor	1
W. Sevenoaks, Acre House, Windsor	1
W. J. McCloskie, Peascod-street, Windsor	1

The number of Directors shall not be less than three nor more than seven, and the qualification of a Director shall be the holding of at least 20 shares in the capital of the Company. The remuneration of Directors shall be voted in general meeting.

Sungei Ujong (Malay Peninsula) Railway Company, Limited. Registered by Ashurst, Morris, Crisp and Co., 6, Old Jewry, E.C., with a capital of £75,000, in shares of £10 each. Object: to enter into and carry into effect an agreement made between Thomas Heslop Hill and Ambrose Beatty Rathbone of the one part, and the Company of the other part, to construct or acquire, and equip, maintain and work railways, tramways, lines of telegraph and telephones, or other means of communication or appliances of a similar nature in the Malay Peninsula, and for the above purposes to enter into and carry into effect any contracts, and apply for, accept, and carry into effect such concessions or authorities as may be deemed necessary or desirable. The first subscribers are:

	Shares.
W. Marshall, 280, Devonshire-road, S.E.	1
A. Mitchell, 278, City-road, E.C.	1
J. Gates, 61, South-hill-park, Hampstead	1
S. Crouch, 173, Isledon-road, N.	1
E. Disney, Steele road, Sydenham	1
E. T. Botwright, 23, Sutton-place, Hackney	1
T. Nettleship, 1, Mildmay-park, N.	1

The number of Directors shall not be less than three nor more than seven, and the first shall be appointed by the signatories to the memorandum of association. The qualification of a Director shall be the holding in his own right of shares or debentures or debenture stock in the Company of the nominal value of £500. The Directors shall be entitled to receive out of the funds of the Company by way of remuneration, from the date of the appointment of the first Directors, £500 per annum so long as their number shall not exceed three, and £150 additional for every further Director up to five.

Lancashire Electric and Engineering Company.—Registered on the 8th inst., with a capital of £20,000, in shares of £5 each, to carry on at Bolton and elsewhere the businesses of mechanical, hydraulic, and general engineers and machine makers, electricians, electrical engineers, and workers and dealers in electric and other motive power and light. The first subscribers are:

	Shares.
*M. Settle, Snow-hill, Darcy Lever, colliery proprietor	1
*J. Atherton, Bolton, mining surveyor	1
*J. Tonge, Westhoughton, mining engineer	1
*G. H. Peace, Tyldesley, mining engineer	1
*G. Crowther, Bolton, mining engineer	1
J. C. Sewell, Bolton, electrical engineer	1
F. W. Briscoe, Bolton, accountant	1

There is not to be less than five, nor more than seven Directors, and the first are the subscribers denoted by an asterisk; qualification, 10 shares.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the past week amounted to £5,842.

Monte Video Telephone Company, Limited.—This Company announce that the certificates are now ready for delivery in exchange for bankers' receipts and letters of allotment.

Eastern and South African Telegraph Company.—This Company announce the numbers of 269 bonds of their five per cent. debentures, which have been drawn for payment on January 1, 1889.

Western and Brazilian Telegraph Company.—The traffic receipts for the past week, after deducting the "fifth" of the gross earnings payable to the London Platino-Brazilian Telegraph Company, were £4,938.

Richard Hornsby and Sons, Limited.—The Directors of Richard Hornsby and Sons, Limited, recommend a balance dividend of 4s. 6d. per share, making a total distribution of 7s. per share for the year ended September 29.

PROVISIONAL PATENTS, 1888.

NOVEMBER 16.

16,629. **Improvements in galvanic batteries.** Ferdinand Cramer, 38, Alexander-strasse, Berlin, Germany.

16,653. **Improvements in electro-motors.** Otto Fronly, 115, Great Russell-street, London, W.C.

16,654. **Reflecting shades for electric lamps.** Charles Mark Dorman and Reginald Arthur Smith, 24, Brasenose-street, Manchester.

16,658. **Improvements in or connected with safety junctions for electric lighting.** Thomas Taylor and William Tunnicliff, 6, Livery-street, Birmingham.

16,681. **Improvements in and relating to multiple telegraphy.** Francis Jarvis Patten, 77, Chancery-lane, London, W.C. (Complete specification.)

16,694. **Improvements in electrical instruments for transmitting information.** Jocelyn Home Thomson, 53, Chancery-lane, London.

NOVEMBER 17.

16,728. **Improvements in dynamo electric machines.** Norcliffe George Thompson, 7, Westminster-chambers, Victoria-street, Westminster, London.

NOVEMBER 19.

16,766. **Improvements in electric lamps or lighting apparatus.** Alfred Lyster Shepard, 45, Southampton-buildings, London.

16,809. **Improvements in voltaic batteries.** Henry Inkson Harris and John Garford, 21, Cockspur-street, London, S.W.

16,813. **Improvements in secondary generators or induction transformers.** Guy Carey Fricker, 39, Montserrat-road, Putney, S.W.

NOVEMBER 20.

16,829. **An improved portable lamp and dynamo combined.** Robert Thompson, 18, Chapel-street, Liverpool.

16,851. **Improvements in apparatus for electro-dynamically controlling motion.** Walter Thomas Goolden and Sydney Evershed, 23, Andalus-road, Clapham, S.W.

16,852. **Improvements in appliances designed for use in connection with variable electric currents, the said improvements being also applicable to alternate current motors.** Walter Thomas Goolden, Llewellyn Birchall Atkinson, and Sydney Charles Gilbey Gold, 23, Andalus-road, Clapham, S.W.

16,855. **A combined electric conductor and interrupter.** Francis Moreton, 188, Camden-road, London, N.W.

16,881. **An improved method for utilizing gas and electricity for illuminating names of railway stations, shop signs, facias, and trade signs generally.** William Sparrow, Harpenden, Hertfordshire.

16,892. **Improvements in electric firing mechanism for breech-loading guns.** Thorsten Nordenfelt, 53, Parliament-street, Westminster.

NOVEMBER 21.

16,900. **Improvements in electrical fusible cut-outs.** Claude Grivolas, jun., Albert Works, Graham-street, Birmingham.

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16,905. **Improvements in or relating to electrical locks.** George Cecil Dymond, 6, Lord-street, Liverpool. (Paul Schwenke, Zerbst.)

16,928. **Improvements in brushes and contacts for dynamo-electric generators, motors, and other purposes.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C.

16,939. **Improvements in the construction of electric bells.** Gustav Binswanger and Herbert J. Coates, 5, Great St. Thomas Apostle, E.C.

16,946. **Improvements in fittings and switches for incandescent electric lamps.** James Yate Johnson, 47, Lincoln's-inn-fields, Middlesex. (Theodore Mace, United States.)

16,947. **Improvements in connection with continuous electric current transformers for automatically regulating the current in the working circuit.** Laurence, Paris, and Scott, Limited, and William Harding Scott, of 47, Lincoln's-inn-fields, London.

16,954. **Improvements in electro-plated goods, and in the process of manufacturing the same.** Frederick Augustus Oetzmann, 24, Southampton-buildings, London, W.C.

16,959. **Improvements in electric contact apparatus to be operated automatically by heat or by hand pressure.** Christian Frederik Hilkier, 18, Buckingham-street, Strand, London, W.C. (Complete specification.)

NOVEMBER 22.

17,002. **An improved fluid for primary batteries.** Theophilus Coad, 1, Quality-court, Chancery-lane, W.C.

17,008. **Improvements in dynamo machines.** Frederick Vilhelm Schiödt, 77, Chancery-lane, London, W.C. (Complete specification.)

17,013. **Improvements in electric meters or apparatus for measuring electricity.** Charles Watson, 46, Lincoln's-inn-fields, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

SEPTEMBER 19, 1887.

12,676. **Improvements in dynamo-electric generators and motors.** Walter Thomas Goolden and Llewellyn Birchall Atkinson, 23, Andalus-road, Clapham, S.W.

DECEMBER 14, 1887.

17,231. **Improvements in means for the distribution of electricity.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

JANUARY 17, 1888.

718. **Improvements in self-acting electric batteries or generators in which the liquids are automatically renewed.** Emile Guitton, 166, Fleet-street, London, E.C. (Marcel Sappey, France.)

JANUARY 21, 1888.

981. **Improvements in electric "call" signal apparatus.** Charles Spratt, 24, Southampton-buildings, London, W.C.

JANUARY 23, 1888.

984. **Improvements in controlling railway signal levers by the application of electricity.** William Frederick Burleigh, 106, Camberwell New-road, London, S.E.

SEPTEMBER 20, 1888.

13,598. **Improvements in electric motors.** Richard Richardson Hutchinson, 4, Little Moorfields, E.C.

OCTOBER 18, 1888.

14,981. **Improved method of and apparatus for actuating printing machinery by means of an electric current, and instantaneously checking or arresting the motion thereof when required.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C.

14,985. **Improved method of and apparatus for utilising a current of electricity for operating pile driving machinery and rendering the action of same automatic.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C.

14,986. **Improved method of and apparatus for applying electricity as a motive power to cranes, sheer legs, and the like.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C.

14,988. **Improvements in "mashers" and "mixers" as employed in brewing and other processes, and method of and apparatus for applying electricity as a motive power for same.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C.

14,989. **Improvements in steering apparatus for ships, and method of and apparatus for utilizing electricity as a motive power for same.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C.

SPECIFICATIONS PUBLISHED.

1877.

*2909. **Controlling by sound the transmission of electric currents, &c.** The Edison Telephone Company's Disclaimer and Memorandum of Alteration. (Fourth edition.) 8d.

1887.

16,296. **Galvanic batteries.** A. F. St. George and C. R. Bonne. 8d.

16,603. **Electric lamps, &c.** A. J. Boult. (Weber.) 8d.

17,155. **Incandescent electric lamps, &c.** T. A. Edison. 8d.

17,508. **Electrical switches.** F. L. Rawson and W. White. 8d.

17,528. **Phonic reception of telegraphed communications.** C. Ader. 8d.

17,762. **Electric signalling apparatus.** L. Sellner. 11d.

17,768. **Insulating wire.** W. S. Smith. 8d.

17,812. **Producing alternating electrical currents.** C. Zipernowski. 8d.

1888.

39. **Voltaic batteries.** E. Tyer. 8d.

804. **Electric clocks.** M. Pulvermann. (Bohmeyer.) 8d.

7826. **Galvanic generators.** H. B. Cox. 8d.

8170. **Automatically regulated electro-motors.** J. H. Allison. (The Baxter Electric Manufacturing and Motor Co.) 8d.

10,524. **Electric railways.** B. J. B. Mills. (The Bentley-Knight Electric Railway Co.) 11d.

11,092. **Combined steam-engine and dynamo-electric machine.** G. M. Capell and J. S. Raworth. 6d.

13,008. **Electric incandescent lamps.** J. W. Olddory. 6d.

13,126. **Electric calls.** W. H. Cutting. 8d.

13,194. **Ungumming and bleaching by electrolysis China grass, &c.** E. M. H. Andreoli. 6d.

13 825. **Electrical conductors.** H. H. Lake. (Silliman.) 6d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	99½
12 Feb.	1/2	Anglo-American Brush E.L.	4	4¼
12 Feb.	2/0	— fully paid	5	5 3/16
26 Oct.	7/6	Anglo-American	100	46½
26 Oct.	15/0	— Pref.	100	78½
12 Feb., 85	5/0	— Def.	100	17½
28 June	3/0	Brazilian Submarine	10	18½
14 June	1/0	Con Telephone & Main	1	1 1/16
10 Aug.	9/0	Cuba	10	14
10 Aug.	10/0	— 10% Pref.	10	18½
12 Oct.	2/0	Direct Spanish	5	4
12 Oct.	5/0	— 10% Pref.	5	10¼
26 Oct.	2/0	Direct United States	20	9 5/16
12 Oct.	2/6	Eastern	10	12⅜
12 Oct.	3/0	— 6% Pref.	10	14⅞
1 Aug.	5%	— 5%, 1899	100	110
26 Oct.	4%	— 4% Deb. Stock	100	105½
12 Oct.	2/6	Eastern Extension, Australasia & China	10	12½
1 Aug.	6%	— 6% Deb., 1891	100	104½
2 July	5%	— 5% Deb., 1900	100	104
2 Nov.	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	105
28 Mar.	8/3	German Union	10	9
12 Oct.	1/0	Globe Telegraph Trust	10	6⅞
12 Oct.	3/0	— 6% Pref.	10	14⅜
30 April	5/0	Great Northern	10	14½
1 March	5%	Gt. Northern 5% Deb., '88.	100	103½
27 July	10/0	India Rubber, G. P. & Tel.	10	17½
26 Oct.	12/6	Indo-European	25	39½
30 May	3/0	London Platino-Brazilian	10	6½
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	⅜
26 April	4/0	Reuter's	8	8
.....	...	Swan United	3½	2⅝
10 Aug.	13½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	40½
2 July	6/0	— 6%, 1889	100	105
12 July	10/0	United Telephone	5	14
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	98½
12 July	4/0	West Coast of America	10	9⅜
30 June	8%	— 8% Debs.	100	115
26 Oct.	6/0	Western and Brazilian	15	13⅝
26 Oct.	6/	— Preferred	7½	6½
11 May	2/1½	— Deferred	7½	7¼
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
.....	...	West India and Panama	10	2⅛
30 May	10/0	— 6% 1st Pref.	10	12⅜
13 May, '80	...	— 6% 2nd Pref.	10	12
2 Nov.	7%	West Union of U.S.	$1,000	122
1 Mar.	6%	— 6% Sterling	100	104

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NOTES.

Algeria.—Miliana, a town of 5,000 inhabitants in Algeria, has just adopted electric lighting.

Paris Bourse.—The Paris Bourse of Commerce is to be lighted by electricity, and compressed air engines will be used for motive power.

Zinc Syndicate.—The news is announced of a syndicate of influential Belgium and German financiers to form a syndicate to control the zinc trade, similar to the French syndicate in copper.

Lambeth.—The notice of the House-to-House Electric Lighting Company of their intention to apply for a provisional order was referred to the Electric Lighting Committee.

Electric Light on the Thames Boats.—At the meeting of the Metropolitan Board of Works last Friday, it was resolved that the Woolwich ferry boats should be lighted by electricity.

Telephones in Casual Wards.—The question of putting up telephones for use at casual wards is being talked about, so as to prevent time being wasted by tramps going to wards already full.

Electric Automatic Box Company.—A petition has been presented by three gentlemen holding a substantial stake in this company to prevent further wasting of the money subscribed by the shareholders.

Extensions.—Further dynamos of the Parker-Lowrie alternating pattern have been despatched to Eastbourne and Brighton. A 70-unit machine, capable of supplying 2,800 8-c.p. lamps, has been sent to each of these stations.

The Royal Society.—The anniversary meeting of the Royal Society was held at Burlington House on November 30. The Davey medal was awarded to Mr. William Crookes, for his investigations on the behaviour of substances under the influence of the electric discharge in a high vacuum.

City Lighting.—There seems a prospect that the electric lighting in the City will shortly be actually carried out. Complete specifications have been prepared, which are now issued, and the Commissioners of Sewers are in a position to receive tenders from those who may be desirous of contracting for the same.

City.—Notices to the City Commission of Sewers from the House-to-House Electric Supply Company and the London Electric Supply Corporation of their intention to apply for provisional orders enabling them to supply electricity for lighting and other purposes within the City were sent to the Finance and Improvement Committee.

Obituary.—The death is announced of M. Lucien Gaulard, of Messrs. Gaulard and Gibbs, under sad circumstances. The trouble with patents for transformers, for which he did so much to prove the possibility in practical work, seems to have preyed upon his mind, and his death, at the early age of 38, is a distinct loss to the pioneers of electrical industries.

Society of Telegraph Engineers.—The annual general meeting of the Society will be held at the Institution of Civil Engineers, 25, Great George-street, Westminster, on Thursday, December 13, at 8, for the reception of the annual report of the council, and for the election of council and officers for the ensuing year. The discussion on the paper by Mr. H. Edmunds, "On a System of Electrical Distribution," read at the last ordinary general meeting, will be concluded.

New Atlantic Cables.—A company of Anglo-Canadian capitalists is being formed to lay a cable from the Straits of Belleisle to Scotland. By way of subsidy, the Dominion is expected to contribute the land for the lines from the St. Lawrence to the Straits. The tender of the Telegraph Construction and Maintenance Company of London, to lay cables from Halifax to Sable Island, for a subsidy of 10,000 dollars for 10 years is favourably reported upon.

Electric Search-Light Experiments. — The efficiency of the electric search-light apparatus, as supplied to British war vessels, was recently exemplified in the Bombay Harbour by her Majesty's gunboat "Mariner," which arrived there from the Seychelles. The night was very dark, but the vessel was able to steam in to a point opposite the Apollo Bunder, where she made fast to an Admiralty buoy. The flashes thrown out by the apparatus rendered Malabar Hill and the whole coast line distinctly visible from Colaba.

Nicaragua Cable.—According to a Panama journal a contract has been signed between the Minister of Public Work at Nicaragua and Senor Crews, by which the latter gentleman receives permission to land a cable on the Atlantic coast of Nicaragua. The journal states that the cable will connect the Nicaragua Republic with the West Indies and New York, and that the Government guarantee that the traffic over the line shall not give less than 6,000dols. per annum. Work on the cable has to be commenced within the next three years.

Provisional Orders.—The following is a list of companies now applying for provisional orders :

Metropolitan Electric Supply Co., Limited (North London).
" " (West London).
" " (South London).
" " (Mid London).
Notting Hill Electric Lighting Co., Limited.
Swansea Electric Lighting.
Westminster Electric Supply Corporation, Limited.
Kensington and Knightsbridge Electric Lighting Co.
London Electric Supply Corporation, Limited.

Ipswich.—The question of overhead wires came on for discussion before the Ipswich Paving Committee. It was recommended that permission should be granted for wires to cross the highways for a limited time, the promoters in the meantime taking all steps necessary to obtain power to lay cables underground. If necessary, the time could be afterwards extended. In the matter of a provisional order, the mayor moved (as costing less money) that it be recommended that assent be given to an application to the Board of Trade for a license. This was agreed to.

The Telephone in Tropical Africa.—It may not be generally known that tropical Africa possesses a tolerably efficient telephone exchange. At St. Paul de Loanda, on the South-West African Coast, different Government departments, and most of the commercial establishments, are telephonically connected, the subscribers numbering about 100. From Loanda, also, a telegraphic line, manipulated almost entirely by the Angolense, extends as far as Dondo, on the River Quanza, 200 kilometres distant, and greatly facilitates business with the extensive coffee plantation in the interior.

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Telephone Conduits.—In Philadelphia the Bell Telephone Company is building a conduit 3ft. wide through the main streets and avenues of the city, which will contain 50 3in. iron pipes, and 50 wooden tubes laid in cement, with a capacity of 100 wires each, a total of 10,000 wires. Connection will be made with each block by a branch running from a main conduit to the middle of the block, and in nearly all the blocks there are small streets and alleys in which the distributing poles can be conveniently erected, leaving the main streets entirely free from wires.

Edinburgh Free Library.—The committee for the erection of the Edinburgh free library have this week had under consideration the question of artificial lighting for the building now in progress. Sir W. Thomson was consulted, and he has, after consultation with Mr. G. Washington Browne, the architect, and Mr. Bryson, the engineer, recommended that, considering the largeness of some of the spaces to be lighted and the smallness of others, the best plan to adopt was a combined system of arc and incandescent lights. The committee have adopted the suggestion, and are now asking for tenders for the work.

Fire at Glasgow.—The electric lights suddenly went out at the Glasgow Post-office on Friday. The report spread that there was fire on the roof. The clerks ran out the hose, and were doing their best to extinguish the flames when the brigade arrived, and in a few minutes the outbreak was got under. The fire was caused, it is said, by some defect in connection with the electric lighting apparatus. Later on the building was lighted with candles. We should have thought that the fuses in a Government building would have been arranged better than this, and should like to know who was responsible for the outbreak.

Electrical Mining in the Transvaal.—At a general meeting of the Graskop Gold and Stores Company, Limited, resolutions were passed to wind up the old company and reconstruct a new one under the name of the Graskop Mill and Mining Company, Limited. The chairman said that the present idea was to build an aerial tramway. Under the new discoveries which had been made in electricity, there was also an idea that with their very excellent water power they could put up a dynamo and transmit the power to the mine and bring their stamps close to where they took out the ore. If this could be done, it would be carried out.

Thetford.—A central station has been started at Thetford, Norfolk. Messrs. Burrell and Sons (whose principal, R. G. Burrell, Esq., is Mayor of Thetford) have lately formed their engineering concern into a limited company. They are devoting considerable attention to the manufac ture of engines for electric light, and have established a central installation in the town in conjunction with Messrs. Laurence, Paris, and Scott, Limited. They are already serving several private and business houses with the light, and have expressed themselves willing to undertake the supply of light to any customers in the town at an annual charge not exceeding that of the present charge for gas.

Willans and Robinson.—New buildings will shortly be commenced for Messrs. Willans and Robinson, at Thames Ditton, upon a considerably larger scale than the old works, and will probably be going in a few months. In order to carry out the orders on hand, temporary arrangements for the carrying on of the work have been made with some of the large engineering shops in London. The erection and testing of the engines will be carried on at Thames Ditton as usual, and tool sheds will be running in a week or two for work specially required to be made on the spot. The number of engines on order is very considerable, very large orders have just been received, and others are pending.

Birmingham.—The Town Council of Birmingham have deferred their consideration of the application for license, and will probably not report until February. In the meantime Messrs. Chamberlain and Hookham have, through their solicitors, given public notice of their intention to apply to the Board of Trade, on or before December 21, under the provisions of the Electric Lighting Acts, 1882 and 1888, for a provisional order, under which action the consent of the Council is not necessary. The power asked for is to enable the promoters to deal with the breaking up of roads, crossing of roads, laying of wires, etc. Notice of objection will have to be addressed to the Board of Trade by February 1, 1889.

Derby Telephone Exchange.—Under the auspices of the National Telephone Company, a telephone exchange was opened last Monday in Derby. The exchange opened with a list of 20 subscribers, and it is confidently expected the number will be at once considerably increased. Derby is on the main trunk line between Birmingham and Sheffield, and communication is opened between Burton-on-Trent, Nottingham, the Black Country, and many large towns in South Yorkshire. In the coming spring there will be direct communication with the metropolitan exchange, which has 5,000 subscribers, as the line is being already laid between Birmingham and London, and will be completed early next year.

Faure's New Accumulator.—M. Bandsept, writing to the *Bulletin Internationale de l'Eléctricité*, regards the new invention of M. Faure as destined to bring about a complete revolution in the construction of secondary and also of primary batteries. The gist of the invention lies in the fact that it substitutes the work of the molecules taken separately for their work taken *en masse*. In the system of M. Bandsept, brought out at the beginning of the year, similar action is obtained by the use of liquid injected in the form of spray employed as reagent specially chosen for each kind of electrode, which acts upon the pores by capillary attraction. In the case of M. Faure, the molecular action is obtained by the laying out, as it were, of the solid molecules for separate action, and of the liquid molecules in M. Bandsept's system.

Barnet.—The Local Board have under consideration the fitting up of three large lamps at the most prominent points of the streets, and have asked the contractors to erect a 2,000 c.p. arc lamp and a 300 c.p. Sunbeam lamp to show what can be done with large lamps. The contractors have agreed to erect these for trial at their own expense. The charge for the arc lamp is fixed at £27 a year; if the steadier but less brilliant Sunbeam lamp, taking the same current, is preferred, this will be run at the same price, and three lamps will eventually be erected. We are glad to learn that the *Barnet Press* has proved practically its adhesion to the new light, and has requested the supply of current for its offices. The supply of light to the church and other places is also under consideration, and numerous orders have been received for private houses when the further plant is started.

Lecture at Bradford.—Mr. W. Lant Carpenter gave a lecture on the telephone and phonograph, last Tuesday, to a large audience at the Bradford Mechanics' Institute

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A practical demonstration was given in the course of the lecture of the use of the telephone. With this object the National Telephone Company, Limited, at the request of Mr. Carpenter, had placed in the hall 20 or 30 receivers, which were distributed about the room for the use of the audience, many of whom were able to listen to music which was being sung or played in one of the Manchester theatres, the Bradford Theatre Royal, and the Grand Theatre, Leeds, and at the local telephone exchange. In the case of the Manchester theatre the microphone was brought into operation. This was one of the features of the lecture, and Mr. Carpenter acknowledged his obligations to the telephone company for similar favours conferred on the occasion of lectures in many other parts of the country.

Electric Execution.—As hanging, says the New York correspondent of the *Daily News*, will be abolished by law on January 1, and no certain mode of killing criminals by electricity has yet been discovered by the authorities, the Medico-Legal Society has recommended what is called an electric helmet. The criminal is to be strapped to a table or chair, the helmet put on, an electrode arranged to touch his spine; the other pole of the battery touches the top of his head inside the helmet. A dynamo, generating an E.M.F. of at least 3,000 volts, will be in the next room. Then, when the circuit is closed, death may ensue in thirty seconds from either a continuous or alternating current. It may; but will it? The philosophers are not able to answer certainly, and none of them has sufficient devotion to science to try the experiment upon himself. But the popular sentiment is that a few mistakes will not matter, as even the murderers sometimes bungle in their work.

Telephone Amalgamation.—The long-protracted negotiations for the amalgamation of the telephone companies are now making satisfactory progress, and there is a near prospect of the union of the United, National, and Lancashire. The conjunction is all the more desirable now that we are also within measurable distance of the metropolis being coupled on to the great Midland and Northern towns. The difficulty of way-leaves has been overcome, but not without much trouble, land owners being found as opposed to the passage of telephone lines as they were in the olden time to railways. The distance to Birmingham is about 110 miles, and along about one-fourth of the road the wires are already up. Early in the new year this trunk line will be completed, and conversation may then be carried on with Birmingham, Leeds, Bradford, Manchester, Liverpool, and other commercial centres. Perhaps this contact with the North may induce Londoners to copy their provincial friends in the free use they make of the telephone.

Cowpen.—The electric light scheme for Cowpen has been abandoned. A letter was read from Mr. William Kelsey (who was present) offering to take the contract for lighting the township at £600 per lighting season for a term of five years. Mr. Todd moved that the tender of Nicholson and Jenning be accepted on condition that the work be completed within two months. It was stated that it would take three months to get the provisional order, and that the Local Government Board, having absolute power, might refuse; plans would also have to be submitted. The motion was put, but only two members voted for it, and the motion was therefore lost. Cowpen has been in darkness for the last four months, and, as the difficulty with the gas company still continues, seems likely to remain so. If the Council are in such a difficulty between the gas company and the provisional order, why do they not get advice from some substantial electrical engineer, and adopt a system with overhead wires? There is no need of provisional order in this case. Otherwise the primeval oil lamp seems their only resource.

Charging Stations.—As the use of portable accumulators for all and sundry purposes increases, they will need recharging, and it is not always convenient to send them to Millwall. We do not know whether the E.P.S. Company intend instituting charging stations in various quarters of London, as Messrs. Immisch are doing up the Thames, but the idea may be worth entertaining. There is no compulsion, however, for users of accumulators to go to the makers for energy, and it is evidently open for any enterprising engineer or owner of power in the neighbourhood of Society's halls to put down a dynamo, keep a few sets of accumulators on drays, and start a storage agency for temporary lighting. Persons with their own cells could also send them to be charged. There is not, of course, a very extensive business to be done in what may be called "milk-cart electricity" as yet, but there are a number of uses for which small sets of storage cells will be continually useful besides that of medical batteries, which is now, perhaps, the most general use to which small supplies of portable electricity are put. But the demand will no doubt spread and become remunerative.

Electric Lighting at the Paris Exhibition.—The international syndicate charged with the lighting of the Great Exhibition in Paris next year is now definitely constituted, and during last week have appeared the various rules and regulations with regard to the lighting. The payment for the light during the whole time the exhibition is open will be at the following rates: For each glow-lamp of 16 c.p., 60f.; 10 c.p., 45f. For each arc lamp of 500 c.p., 500f.; 1,000 c.p., 750f. These prices have been arrived at on the basis of a service extending over 900 hours. Beyond this time there will be an additional payment, for which payments per hour are as follows: For each glow lamp of 16 c.p., 4c.; 10 c.p., 3c. For each arc lamp of 500 c.p., 75c.; 1,000 c.p., 1fr. The motive power will be furnished at the following rates: Up to 500 h.p. hours 50c. per h.p. hour, and beyond 500 h.p. hours 40c. per h.p. hour. The total illuminating power of electric lamps is estimated at 1,600,000 candles; and the number and types of lamps at present decided upon are as follow: Jablochkoff candles, 124; arc lamps, 1,017; glow lamps, 9,080; sun lamps, 16.—*Industries.*

Electric Omnibus.—The Ward electric omnibus is often to be seen on its peregrinations in the early or late hours. On Tuesday morning it left its stables in James-street, Haymarket, passing through Oxenden-street, down through Coventry-street, through Regent-street and Conduit-street to Bruton-street; then by the south side of Berkeley-square, through Charles-street into Green-street, South-street, to Park-lane, through Park-lane to Upper Brook-street, thence to Grosvenor-square, and *vid* Regent-street, back to the stables at James-street, Haymarket. This electric omnibus is said to be the only one in the world actually at present able to run on the ordinary streets without rails, and taking its place among other vehicles drawn by horses. The electric omnibus said to be running in Paris turns out to be a tramcar, and not a true omnibus. The Ward electric omnibus, however, is meant to take its place without preparation of the roads,

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and has now been tried on all the sorts of road to be met with in London streets—macadam, paved, asphalte, wood blocks, etc.—and has been successfully run upon the most difficult up and down hill grades on which vans are run in London.

A New Electric Lighting System.—It would seem to be difficult to evolve a perfectly new and original system of public lighting by electricity, but it has been done—this time by a Frenchman. M. G. A. Tabourin, ingénieur mécanicien, 37, Rue de Passy, has written to the Municipal Council of Paris offering to light Paris upon his system, which will do away with underground mains, and permit the rapid extension of electric light throughout Paris without interfering with the gas companies. In this most wondrous proposal each gas lamp is to be furnished at its base with a small rotary gas-engine, 10in. in diameter, with a small dynamo; and these small installations are to supply arc lamps on the top of the lamp-post, thus burning gas at the bottom, and producing electric light at the top of each post. The inventor offers to run at his own cost for several days, opposite the Theatre Français, one of these electric lights on his new system. It is just possible there may be some practical use for such a combination for production of single arc lamps for photographers, etc., by the consumption of gas, but even if there proves to be anything in the small rotary gas-engine we should imagine the offer to fit up the public lamps of Paris in this manner is a good deal of the nature of a bold advertisement.

Sliding Scale.—The introduction of a sliding scale in charging for current seems to be a step in the right direction, and greatly encourages prospective users to give in their adherence to the electric light. This method of charging is to be adopted at the West Brompton station, and has for some time been successfully in operation at Eastbourne, where the demand for light has increased enormously lately, and this increase is thought to be greatly due to the introduction of the sliding scale of charges. As a result the electric light company at Eastbourne are tremendously busy in new extensions, and are requiring good wiremen. On the sliding scale the charge of 1s. per Board of Trade unit for the first 100 hours is reduced in the second 100 hours to 8d. per unit, and to the rate of 4d. per unit for any further quantity consumed. For an installation of 40 lamps, burning an average of 20 lamps five hours a day during the winter quarter of 92 days, at 50 watt per hour, the amount would be 460 units: for this on the above scale of charges, and adding 5s. for rent of instruments, and nine renewals at 4s., gives a total of £14. 16s. 4d., equivalent to 6½d. per unit, or less than 4s. per thousand cubic feet of gas. It is evident that large customers will not hesitate so much if they are accorded an advantage for using a quantity. This is sometimes separately contracted for in existing supply stations, but the sliding scale of charges is the method which will very probably be universally adopted in electricity, as in gas, and it may be well, wherever possible, to introduce it from the beginning.

Honolulu.—A correspondent of the New York *Electrical Review* says that one would hardly think of going into the middle of the Pacific, to a country just emerged from barbarism, to find modern electrical developments, but it is questionable if there is any place in the world so thoroughly up with the times in this respect as Honolulu, the capital of the Hawaiian Islands. With a population of about 2,000, it supports two telephone companies, having altogether 1,000 subscribers. Every tradesman has one in his store, and almost all residences of foreigners are supplied, so that it is possible to talk to almost any one of your acquaintances in the town, and transact all necessary business at the telephones. The Mutual Telephone Company ran a wire over the reefs to connect with vessels in the harbours, and many a long pull ashore was saved by a shout, "hello!" Several long lines extend to the plantations and ranches outside of the town. The convenience of the telephone is probably better illustrated here than at any other town in the world, and is due to its universal use, which in turn is brought about by low charges, these ranging from 24dols. to 36dols. a year. It is interesting to note that at these rates the companies state that they make money. Electric lighting is represented by the Thomson-Houston Company, who had a station about three miles out of town up the Nuuanu Valley, operated by water power, from which they light the town with about 60 arc lights. The lighting is under control of the Government, and is admirably carried out. It is intended to increase the plant by the introduction of alternate current dynamos for incandescent lighting, and while the manager, Mr. Faulkner, has gone to the States to procure the apparatus, a large reservoir to supply an increase in water power is in process of construction, to admit of future development. At present incandescent lighting is represented only by a Thomson incandescent plant of two 200-light dynamos, which light the palace and hotel. Honolulu is wide awake electrically, and has energetic and capable men to advance electrical interests.

Electric Sugar.—The correspondent of the *Financial News* cables from New York the following report with reference to the latest trial of the Electric Sugar Company on December 3: "I have witnessed to-day the first thorough test, with completed plant, of the electric sugar-refining process. It was made at the Electric Sugar Company's works, which are located in Hamilton-avenue, Brooklyn. The building is five storeys high. The top floor is used for receiving raw sugar and discharging it into a chute. The two floors beneath are occupied by the refining process, and nobody is admitted here except those possessing the secret. The sugar is discharged on to the floor below through nine different chutes, each chute delivering a different grade as to size and quality. The two tests previously reported were made with partial plant. The result of to-day's run was 50 barrels of perfectly snow-white crystallised sugar of the highest quality, all made in 128 minutes. There were several stoppages incident to newness of machinery, etc. While the machinery was running, one barrel of sugar was turned out every two and a half minutes, nine streams running at once. There was no preparation for boiling sugar, nor bone black filtering, and no smell such as is inseparable from the old methods. Old refiners present conceded that the granulation was entirely different from that of common refined sugar. Mr. H. C. Highet, formerly of Liverpool and now of New York, and Mr. Willett, the leading sugar refiner of New York, expressed great satisfaction at the result. Only three men and one woman were engaged in the refining-room, while in the granulating department, on the floor below the refining-room, there were two men and one woman, making only seven altogether who were connected with the operation of refining. Mr. Willett says that at the rate of to-day's run it would take 50 men two days by the old process to accomplish the same result. Very early next year it will be possible for the company, to start refining about 2,000 barrels per day for the market.

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and when the factory is in full operation it will be able to turn out about 4,000 barrels per day of 24 hours. The reason why the operation will not be commenced before early next year is connected with the securing of patents." There seems to be a new spirit animating the workers of this company according to the last sentence. If patents are to be taken out for the process, we may be able, after all, to judge of the practicability of the invention from something besides mere statements.

Chelsea.—At the meeting of the Chelsea Vestry on November 28, the Electric Lighting Committee reported that they had considered a letter from Major Waller, on behalf of the London Electric Supply Corporation, dated November 13, requesting permission to lay an underground cable along Pavilion-road, as shown on an accompanying plan, and the committee recommended that the application be granted subject to the terms of the Chelsea Electric Lighting Order, 1886, being embodied in an agreement between the corporation and the Vestry, and during the pleasure of the Vestry. With reference to this recommendation, a deputation of four gentlemen representing the Chelsea Electric Supply Company was introduced by General Webber. General Webber said it had been arranged for Lord Thurlow to speak on behalf of the deputation, but his lordship had not arrived, and had probably been detained at the House. In his absence, General Webber proceeded to ask that the Vestry would not approve the recommendation of the Electric Lighting Committee set out above. He did so on the ground that such an introduction by the Vestry of competition in the supply of electric light in that part of Chelsea known as District A, for which his company had a provisional order, would be a serious disadvantage to them. The deputation having retired, Mr. Mossop then moved the adoption of the committee's recommendation to grant the application of the London Electric Supply Corporation for permission to lay an underground cable along Pavilion-road during the pleasure of the Vestry. He reminded the Board that the Electric Lighting Act was opposed to the establishment of any monopoly. The Vestry had also to protect itself from the introduction of overhead wires. They had no power to insist on underground wires, but both the Cadogan Electric Light Company and this London Electric Light Corporation relieved them of the difficulty by volunteering to give undertakings to lay their wires beneath the pavement. The Vestry having thus got the power into its hands again should not sanction any monopoly, but only consider the interests of the ratepayers. The chairman then put Mr. Mossop's motion to the vote, and it was carried unanimously, the deputation being informed of the decision. It was also resolved, on the recommendation of the committee, that the application of the Cadogan Electric Light Company for permission to lay a 2in. iron pipe beneath the pavement, from their works in Manor-street to the Chelsea Embankment, be granted; and also that in all future cases in which the pavement is disturbed for the laying of electric wires or cables the Vestry relay the pavement at the cost of the company.

The Vienna Central Electric Light Station.—By invitation of the Imperial Continental Gas Association, says the Vienna correspondent of *Industries*, the members of the Vienna Society of Electricians inspected recently the electric light station which was established in the Schenkenstrasse some three years ago, and about which there has been so much controversy. As already reported, the installation, as erected in the first place, gave rise to some legal difficulties with neighbours, who complained of the vibration; but these difficulties have now been overcome by a complete rearrangement of the machinery. The original boilers which failed have also been replaced by 10 Babcock and Wilcox boilers, arranged to work at 150lb. pressure, and each having a heating surface of 1,400 square feet. The main steam-pipes are in duplicate, to guard against interruption of service in case of a pipe bursting. The feed water for the boilers is taken from the Danube; but, being very impure, it is first sent through purifiers, of which there are three provided, each capable of dealing with 4½ tons of water per hour. Storage tanks are provided for the feed water, with a total capacity of 260 tons. Feed water heaters are also used. The engine-room, which formerly was on the ground floor, has now been transferred into the basement, and is on the same level as the boiler-room; whilst the ground floor has been utilised for a repairing shop, and contains a lathe, fitting benches, and a winding apparatus, on which field-magnet coils can be wound. Power is supplied to this shop by a small electromotor. There are travelling cranes and tramways in the repairing shop and machine-room. On the occasion of the visit referred to, the repairing shop was utilised for the exhibition of apparatus, machinery, and diagrams in connection with the working of the station. Among the diagrams was a very interesting load curve, showing the consumption of current during the performance of the ballet "Excelsior," the current from the station being almost exclusively used for the lighting of the Vienna Opera and Burg Theatre. On account of the special scenic effects introduced into this ballet, the consumption of current is exceedingly irregular, and attains for short periods a maximum of 900 amperes. The current is supplied by storage batteries, some of them being of the E.P.S. and others of the Schenek-Farbaky type, which are charged at a constant current, under an E.M.F. force of from 400 to 500 volts. The charging current is supplied by a battery of Willans-Crompton steam dynamos. Three of these have an output of 100 kilo-watts each (250 amperes at 400 volts), and five have an output of 75 kilo-watts (140 amperes at 540 volts). A powerful fan of about 6ft. diameter is provided to keep the armatures cool. These dynamos are separately excited by four smaller machines, each giving 160 amperes at 50 volts. Opposite this array of 12 dynamos is fixed the main switch-board, consisting of the usual horizontal omnibus bars and vertical cross-bars, with plug connections, by which any desired combination between dynamos and mains can be effected. Over each main is provided a testing apparatus, consisting of a series of lamps fed from the mains, the middle of the series being connected to earth. As long as the lamps on each side of the earth wire burnt with equal brilliancy, the insulation of the mains is perfect; but should a leak on one or other of the mains occur, the indicating lamps at the station will at once brighten up on one side, and become dull on the other of the earth wire, thus giving notice of the defect. The measuring instruments used at the station are of various types—viz., the Kapp-Crompton indicators and the Schuckert-Drexler ampere and volt meters. The machine-room and boiler-room are lighted by "Sunbeam" lamps, current for these being supplied by a special little installation, consisting of gas-engine, dynamo, and accumulators.

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THE MAGNETIC FIELD.—VI.

The quantity of electricity, ampere seconds or coulombs, forced through a given circuit by the development of a given field within the circuit can be determined by reference to equation (8). It was then shown that the E M.F. created within the circuit is equal to the rate of increase or decrease in the total induction. Let, in Fig. 12, A be a magnet, or rather a piece of iron, which can be transformed into a magnet at will, say, an electromagnet, the limbs of which are surrounded by exciting coils not shown in our sketch. We make, at present, no assumption as to the relation between the current in these coils and the field created by it. Suffice it to note that we can call forth a more or less powerful field at will, and that we can regulate the rate at which this field grows by simply regulating the exciting current. Between the poles, N S, of this magnet, we fix a coil, C, of sufficiently large dimensions as to surround all the stream-lines passing across, and we connect this coil with an electricity-meter, M, which indicates the number of coulombs passed through the circuit during a given time. Now, let us suppose the meter stands at zero at the beginning of the experiment, when the magnet is not excited. Then let us send suddenly a strong current through the electromagnet which produces the total induction, N. The meter will indicate the passage of a certain quantity of electricity. Let us then interrupt the current, put the

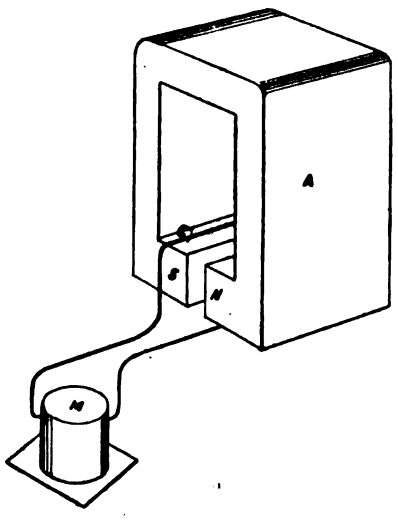

FIG. 12.

meter back to zero, and again excite the magnet, but this time starting with a very weak current, which we gradually increase to the former value. The meter will, in this case, move more slowly, but finally it will reach the same point, showing that the total quantity of electricity is exactly the same. The total quantity of electricity forced through a circuit by magnetic induction is independent of the rate at which the induction takes place, and depends only on the final value of the induction. That this must be so can easily be seen from equation (8). We found there that the E.M F. developed in a single loop of wire at any instance is given by the rate at which the induction changes. If instead of a single loop we employ a coil of τ turns, the E.M.F. will be proportionately greater.

$$E = \tau \frac{dN}{dt} 10^{-8} \text{ volts.}$$

By Ohm's law, and neglecting for the moment certain disturbing phenomena (like heating of the wire, self-induction in coil, C, and change of apparent resistance by unequal distribution of current throughout the cross section of the wire), we know that the current flowing at any time equals the E.M.F. divided by the resistance, R, in the circuit, that of the meter included.

$$c = \frac{\tau}{R} \frac{dN}{dt} 10^{-8}$$

The quantity of electricity which this current carries through the meter in the infinitely short space of time, $d\,t$, is obviously $c\,d\,t = \frac{\tau}{R} d\,N\,10^{-8}$; and by integration we find the total quantity passed during the time that the field has grown from zero to N, expressed in coulombs,

$$Q = \frac{\tau N}{R} 10^{-8} \quad \ldots\ldots\ldots \quad (9)$$

It will be seen that the quantity depends only on the induction, N, the number of turns τ in the coil and the resistance of the circuit, but is independent of the precise manner in which the change of field from zero to N takes place. If the field is let down again to zero, exactly the same quantity will pass through the meter, but in the opposite direction. The process here described of the transfer of electricity through a circuit by the creation and extinction of a magnetic field is the principle upon which alternating current transformers are based, and it will therefore be useful to illustrate it by a numerical example. In a transformer there is no air-gap between N and S, but this circumstance does not influence the creation of E.M F., provided that we take care by some means to produce the total induction, N, whatever the width of the air-gap may be. Let the poles be 10cm. deep by 50cm. wide, and assume the same induction, B, as before—namely, 4,000. The total induction is then N = 500 × 4,000 = 2,000,000. Let the coil consist of 100 turns of 77 mils wire having a resistance of ·53 ohm per 100 yards. The length of one turn will be about 1·5 yards, and the total length of wire contained in the coil 150 yards, giving a resistance of ·8 ohm. Neglecting the resistance of the meter, which will be very small, we can now find the total amount of electricity which will pass through the circuit each time we produce or extinguish the field. From equation 9 this is

$$Q = \frac{100 \times 2{,}000{,}000.10^{-8}}{\cdot 8}$$

$$Q = 2\tfrac{1}{2} \text{ coulombs.}$$

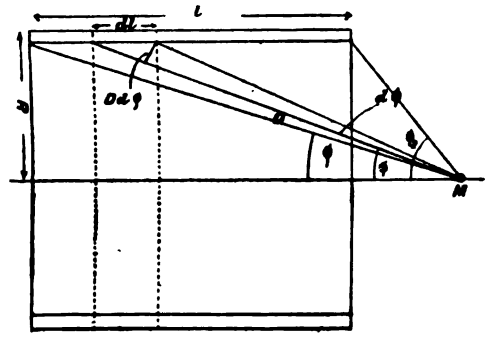

FIG. 13.

Now, suppose that we insert into the circuit a group of 10 ordinary 100 volt 16-c.p. glow-lamps coupled parallel. Their joint resistance, hot, would be a little over 16 ohms—say, 17 ohms for the whole circuit. With such a resistance there would pass only 2/17 = ·117 coulombs each time the field is made. If it takes one second to produce the total field, the average current would be ·117 ampere. If we produce the field at a quicker rate—say in one-tenth of a second—the average current would be 1·17 amperes. This would not be sufficient to bring the lamps up to incandescence. For this purpose there would be required an average current of about six amperes, and this can be obtained by still further increasing the speed at which the field is produced and extinguished. It will be necessary to produce the field in the $\frac{1}{50}$th part of a second in order to raise the current to an average value of six amperes, and the lamps will be sustained in an incandescent state if we alternately produce and extinguish the field in this space of time, so that during one second the field attains 25 times its maximum value and descends 25 times down to zero. An apparatus of this kind is called an alternate current transformer, but in practice it is somewhat differently arranged and worked. In the first place, there is no air gap, and in the second place the field is not only let down to zero, but it is also reversed, so as to attain a maximum negative value. The change in the field is produced by an alternating current flowing in coils, which surround the limbs of the magnet, A.

We have given the above examples merely to demonstrate the inter-action between magnetic fields and electric currents,

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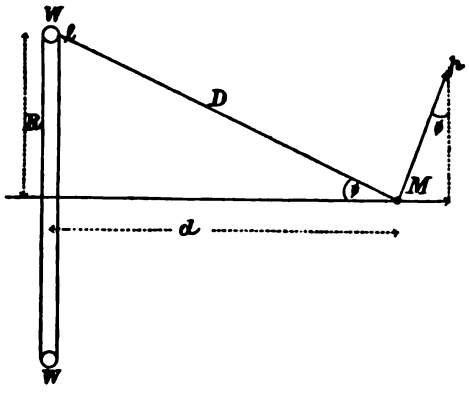
and shall now proceed to show how a magnetic field is produced by an electric current, and how the strength of the field can be calculated from the construction and electrical data of the apparatus employed. This question is of special importance, as artificially produced fields (as distinguished from the fields of permanent steel magnets) are almost exclusively used in all dynamo electric machines. The problem, therefore, is to determine the total induction produced in a given configuration of electromagnet to which a given magnetising or exciting power is applied, and for a solution we must now go back to equation (2) in article IV., where it was shown that the force exerted upon unit-pole placed in any point along the axis of a circular current is

$$F = \frac{2\pi R c R}{D^3}. \quad . \quad . \quad . \quad . \quad (2)$$

For convenience in the interpretation of this formula we repeat here the diagram then given:



Instead of employing a single coil of wire, we may use a broad sheet of metal bent into a cylindrical form and send a current, C, through it. If l denote the width of the sheet—that is, the length of the coil—the current flowing through a strip 1cm. wide will be $c = C/l$, and the current flowing through a strip of the width dl will be $dc = c\,dl$.

The field produced by the infinitely narrow strip of current dl is, therefore,

$$dF = \frac{2\pi R c R\,dl}{D^3},$$

$$dF = 2\pi c \frac{R}{D} R \frac{dl}{D^2}$$

Now, it is evident from the diagram that $dl = \frac{D\,d\phi}{\sin\phi}$ and $R/D = \sin\phi$; hence,

$$dF = 2\pi c \sin\phi \sin\phi \frac{d\phi}{\sin\phi},$$

$$dF = 2\pi c \sin\phi\, d\phi,$$

which integrated between the limits ϕ_1 and ϕ_2 gives the total force exerted by the current upon unit pole placed at M,

$$F = 2\pi c (\cos\phi_1 - \cos\phi_2).$$

If the cylinder be short and the pole M be placed a considerable distance away, the angles ϕ_1 and ϕ_2 will be sensibly equal, and the force will be zero. On the other hand, if the cylinder be long and the pole placed in the middle, the angle ϕ_1 will be nearly zero, and the angle ϕ_2 nearly 2π, in which case the force is

$$F = 4\pi c.$$

The same force would be exerted by each turn, supposing the metal sheet were lapped several times round. Let τ denote the number of turns, and remembering that $c = C/l$, we find

$$F = \frac{4\pi\tau C}{l}.$$

The product, τC, signifies turns multiplied by current in absolute measure, or ampere turns divided by 10 in the practical system of measurement. Writing P for existing power in ampere turns, we have therefore

$$F = \frac{4\pi P\,10^{-1}}{l}.$$

Since the force, F, exerted on unit pole equals the induction, we can also write for the induction in the centre of the cylinder

$$B = \frac{4\pi P\,10^{-1}}{l}. \quad . \quad . \quad . \quad . \quad (10)$$

And it may be here remarked that the cylinder need not necessarily be composed of a broad sheet of metal, but may consist of a number of layers of insulated wire wrapped into a cylindrical form so as to fill the same space as the sheet. The symbol τ in this case signifies the number of turns in each layer multiplied with the number of layers, or the total number of turns contained in the coil, and the exciting power, P, is the product of current and number of turns. This existing power is exerted by the whole length, l, of the coil, or solenoid, as it technically termed, and the quotient, P/l, represents, therefore, the ampere turns due to one centimetre of solenoid. Writing p for this quantity we have

$$B = 4\pi p\,10^{-1},$$

$$B = 1{\cdot}256\,p \quad . \quad . \quad . \quad . \quad . \quad (11)$$

This formula is useful because showing at a glance what induction is produced in the centre of a solenoid B. In our view of the magnetic field this represents velocity of magnetic stream-lines at that point; in the orthodox way of regarding magnetic phenomena this is variously called "magnetic force," 'magnetising force," and "strength of field," and is generally denoted by the symbol H. It is generally made the basis or starting-point in experiments upon the magnetic properties of iron and other metals. Thus, when we read that Dr. Hopkinson in his experiments used a maximum magnetising force of 240, we know that each centimetre of the solenoid employed provided about 190 ampere turns of exciting power. It is necessary to clearly distinguish between magnetising force and exciting power. The former is the force which propels what we have called the magnetic matter along the stream-lines, and is thus analogous to pressure in hydro-dynamics. The latter is merely a conventional term, and only acquires a scientific meaning when we know the length of the coils in which it is developed. Thus, an exciting power of 10,000 ampere turns (which is a fair average value in modern dynamo machines) conveys by itself no meaning whatever as to the intensity of the force which causes the flow of magnetic matter. But if we know the length of the magnet-coils the meaning becomes at once definite. With coils having a total length of 50c.m. it would correspond to a magnetising force of $200 \times 1{\cdot}256 = 251{\cdot}2$; with coils of twice this length the magnetising force would only be half this amount. In the one case we drive the magnetic matter round a short circuit with high pressure per unit length of coil, whilst in the other we employ a lower pressure and a longer coil.

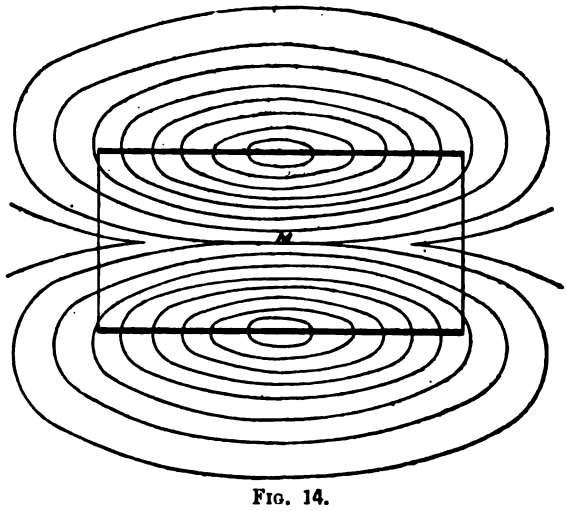


Fig. 14.

The expression for the induction (given in formula 10) was deduced for a point, M, placed into the centre of the solenoid. At any other point the induction will have a different value, and the force may act in a different direction. If we explore the field of a solenoid by means of a magnetic needle we shall find the stream-lines running in the manner roughly represented by Fig. 14. As far as the centre M is concerned, the action of the solenoid may be compared to

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that of a tube, through which flows a stream of magnetic matter; but this representation will only be correct for all points if we assume the tube to be porous, and porous to such a degree that a good many particles of magnetic matter, instead of being shot out at the end, find their way through the wall of the tube. The field, in other words, will be diffuse. Now, if we wish to concentrate it at the ends, we can do so by placing a bar of iron into the solenoid. Experiment shows that iron has the power of concentrating the field—that is to say, of holding the stream-lines together to a far greater degree than air. We cannot explore the course of the stream-lines within the iron, but in the surrounding space they will appear as represented in Fig. 15. The experiment shows that not only has the induction at the ends of the solenoid been increased by the insertion of the iron core, but that in the middle of the solenoid it is also much greater than it was formerly. It is as though the presence of the iron had increased the propelling force of the solenoid upon the magnetic matter within—that is to say, had increased the velocity of the stream of magnetic matter.

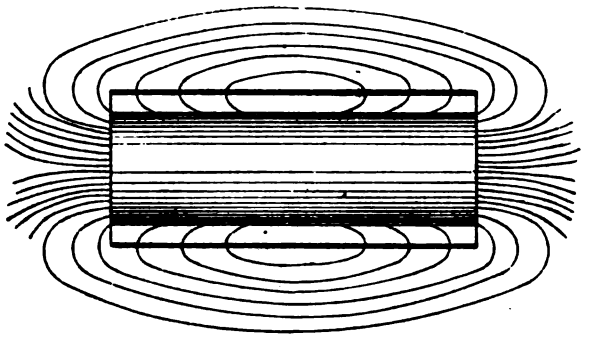

FIG. 15.

This power of increasing the induction may be explained on the hypothesis that all bodies offer a certain resistance to the flow of magnetic matter, but that this resistance is different with different materials. In other words, all bodies are not equally permeable to magnetic matter, and the higher the magnetic permeability of a body the more magnetic matter can be forced through it with a given magnetising force. It is thus possible to express the suitability of a body for magnetic purposes by a coefficient denoting its permeability as compared to that of air, which is taken as unity. This coefficient is generally represented by the symbol μ, and may vary between one or less than one for certain metals, and 2,000 or even more for soft annealed iron. The permeability is even for the same specimen not constant, but varies with the induction. For our present purpose we need, however, not take account of these variations. It suffices to know that the induction is increased in a measure determined by the coefficient of permeability, whatever that may be, under any given circumstances. We have, therefore, the following expression for the induction in the centre of the iron core in Fig. 15—

$$B = \mu \frac{4\pi P 10^{-1}}{l} \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

ELECTRIC LIGHTING IN BRISTOL

Electric lighting is by no means in evidence in this populous and busy Western city, and the individual who sets to work to ferret out installations will probably have his trouble for his pains at the end of the day. Happening to be in Bristol a few days since, we enquired of intelligent policemen and others as to the whereabouts of a certain central station of which we remembered to have heard in bygone days. The good folks raised their eyebrows in polite surprise; they had never heard of such a thing. Presently, however, we stumbled across a constable who had some recollection of having seen electric lights a long time ago in a certain bye-street, to which he directed us. Here we eventually found ourselves, but, alas, the "central station" was not. An inhabitant of this rather unpleasant locality informed us in answer to questions that "that 'ere place had been shut this long time." There could be no doubt as to its identity, for the legend on the doors was still plainly to be read, if a tall pole on the top of the building, with a wire or two still hanging disconsolately from its summit, had not sufficiently indicated the site of the deserted station.

However, knowing the value of pertinacity in matters like this, we pursued our enquiries in the neighbourhood of the old station, and were at length rewarded by discovering some incandescent lamps on the premises of Messrs. H. H. and S. Budgett and Co., of Nelson-street, a very old established firm of merchants. Through the kindness of these gentlemen, we are now able to give a few details of this installation, which, though small, has several interesting points about it.

Believing, as we do, in the superiority of the electric light over other means of lighting, and especially gas, it is a pleasure to come across a case where it has been adopted, not only on its merits, but in spite of that which might have been supposed to create prejudice against it. Originally, Messrs. Budgett were supplied with current from the central station to which we have just referred, but the lights were very unsatisfactory. Instead, however, of returning to gas, the firm, being satisfied that the faults observed could be rectified, determined to put down an installation of their own. The work was entrusted to Messrs. Christy, Son, and Norris, of Chelmsford, and was carried out under the superintendence of Mr. Christy, jun.

The machine-room is in the basement, the dynamo one of Crompton's compound wound, giving 90 volts at 850 revolutions, being driven off shafting by a 12 h.p. Otto gas-engine. There are 90 Edison-Swan lamps, which are distributed throughout the offices. Finding that, as is generally the case, there is occasionally a slight pulsation in the lamps, Messrs. Budgett have determined to overcome this and complete their installation by the introduction of E.P.S. accumulators, 48 of which, with automatic cut-out, will probably be in working order by the time these lines are in print. The installation has been in constant use for the last three years without any hitch or accident, if we except the slight pulsation above alluded to.

The firm expressed themselves well pleased with the light, and make no secret of the fact that though they may pay a certain percentage more for it than for gas, they have adopted the former for the sake of their employés' health and the increased cleanliness it affords. So that here is a case in which the electric light has been adopted by shrewd merchants, not likely to throw their money away on experiments, purely on its merits, and for the sake of its good qualities, as compared with other illuminants. We may congratulate Messrs. Christy on the satisfactory working of the installation.

As there is no rose without a thorn, so there is one drawback to the pleasant state of things just described, and that is the question of renewal of lamps and their cost. Like ourselves, Messrs. Budgett are looking forward to the day when lamps will be made to standard sizes, and sold at every ironmonger's or oilman's shop at a moderate price.

Though time did not permit of our pursuing our enquiries much further, we heard before we left Bristol that the electric light is used also by Messrs. Grace Bros., millers; by Mr. John Lysaght, at his Redcliffe Iron Works; and at the dock engineer's office, though in the latter case we believe it is not relied on to the exclusion of gas, and is only used occasionally. So far as we could learn, however, these were the only other installations besides that at Messrs. Budgetts. Verily, Bristol is still far behind Taunton and Bath.

THE GEYER-BRISTOL METER FOR DIRECT AND ALTERNATING CURRENTS.*

BY PROF. WILLIAM E. GEYER.

In the meter about to be described we make use of the heating effect of the current. Electric measuring instruments depending on this heat effect are not new, as in the Cardew voltmeter we have an application which has found much favour. Here the current of greater or less strength

* Read before the American Institute of Electrical Engineers, New York, Nov. 13, 1888.

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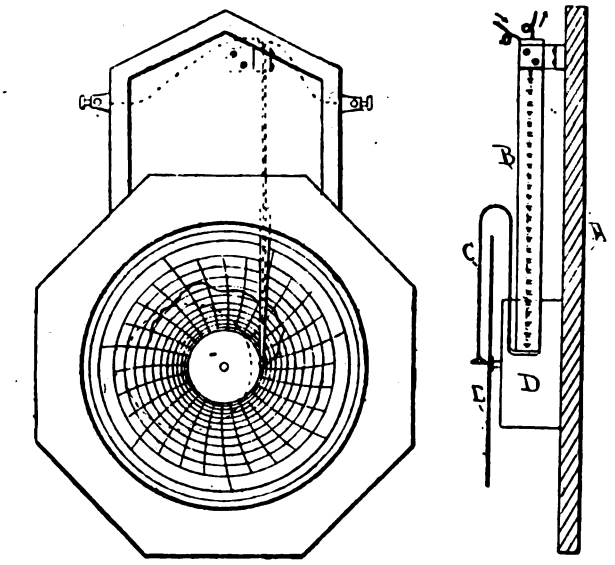
traverses a long thin wire, heats it more or less, and the direct expansion is a measure of the current, and indirectly of E.M.F.

In an ammeter it is necessary to keep down the resistance, and I therefore doubt whether direct expansion can be usefully applied for this purpose; for the actual elongation of a bar of metal, even when raised through a considerable range of temperature, is very small. In the familiar compound bar we have a case where a very small actual elongation produces a relatively very great lateral displacement.

I think I shall best be able to explain to you our meter by recalling to your minds this old device. In the simplest compound bar two strips of metal which have different coefficients of expansion are securely soldered flatwise along their entire length. Brass and steel are metals frequently employed. On heating, the brass expands more than the steel, and, in consequence, the bar bends, becoming convex on the side of the brass. When such a bar is heated by the passage of the electric current, it will deflect, and this deflection may be made a measure of the current. The disadvantage of such an instrument would be that atmospheric changes of temperature would also cause deflection, so that troublesome corrections would have to be introduced.

In our meter we also use a sort of compound bar, but eliminate at once the effect of the surrounding temperature by taking metals whose coefficients of expansion are the same or sensibly equal; in fact, we take the same metal. Our first form of construction was as follows: A wire of german silver is laid upon a strip of german silver of considerably greater cross-section and radiating surface.



FIGS. 1 AND 2.—The Geyer-Bristol System.

The wire and strip are soldered together at one end, separated for the remainder of the length by a film of mica, then tied together at frequent intervals with silk or other insulating material, and suitably supported or clamped at the unsoldered end. If now a current, either continuous or alternating, is allowed to enter the strip at one end, it runs along its length, there enters the wire, and leaves the instrument at the other end of the wire.

For a given current the wire, on account of its greater resistance, and also on account of its smaller radiating surface, becomes hotter than the strip. In consequence of the difference of expansion the bar bends, becoming convex on the side of the smaller conductor. This combination we call a differential bar.

We would also state that inasmuch as the results obtained by the use of this instrument are due to the excess of the heating effect of an electric current upon one portion of the bar, or its equivalent, over the other, it is in a measure immaterial to the principle of the invention whether the current which produces the differences in temperature be caused to heat the two parts directly or indirectly. For example, the more expansible part, in lieu of being included directly in the circuit, may be arranged in close proximity to, but insulated from, a wire or conductor which is heated by the current. The other part or element may be in the circuit or not, but in either case formed or arranged to be less sensibly heated than the other.

It will readily be seen, however, that to heat one or both of the parts of the device in this manner would be clearly equivalent to connecting them both in series in an electric circuit. Unlike the case where magnetic action is employed, the force here available is very considerable, so that to make the instrument self-recording it is only necessary to attach an inking device to the free end and move in front of it a properly ruled chart. In this respect we have no difficulty whatever. My associate, Prof. Bristol, who has done the larger part of the work, has, since our first experiments, very much simplified the method of constructing the differential bar, and the one used in the instrument exhibited was made by placing a flat strip of german silver between a pair of dies which make alternate depressions and elevations along the length of the bar; the wire, insulated with asbestos, was then slipped in the tube-like space thus formed, and the whole pressed between plates provided with grooves of the proper depth so as to leave the wire to one side of the centre line and at the same time to ensure its being held firmly by the little bridges along the length of the bar. Since the bars can be constructed essentially by these two machine operations, it is evident that they may be readily reproduced and at very small cost.

We have determined experimentally the best relation between the cross-section of the strip and wire to give maximum deflection. We believe the instrument could readily be made integrating, but doubt the desirability of doing so. Our reason for this could probably not be better expressed than in the words of an eminent engineer, Mr. Charles E. Emery, in his paper on "Heating Cities by Steam," before the Franklin Institute, which we quote as follows:

"It was at first considered unfortunate that a reliable meter could not be obtained, which, like a water-meter, would show by differences of reading the quantity of steam used for the interval between observations directly without calculation, and without expense of maintaining a time register at each location, and of integrating the charts afterward. This system, however, proved a blessing in disguise. The greatest difficulty in settling with consumers lies in the fact that employés waste the steam. This is particularly the case during the heating season, when steam for various uses is left on continuously during nights and Sundays, thus increasing the time of consumption from, say, 60 hours a week to 168 hours. In many cases, too, the rate of consumption keeps uniform during the night as well as during the day, so that it is an easy matter to more than double the bills. The consumers at first naturally lay the blame to the steam of the steam company, but the meter charts have been the means of enabling the company to satisfy consumers when, and to what extent, the increased bills were due to mismanagement on their premises."

Substitute electricity for steam and the reasoning will apply perfectly to our case.

In the accompanying illustrations Fig. 1 is a general view of the differential bar, mounted in a case with inker and recording dial. Fig. 2 is a side view of the important parts, the case being removed.

The following letters refer to the different parts:

A, supporting framework; B, differential bar; C, inking pointer attached to bar; D, clockwork moving dial; E, revolving dial for receiving record.

Electric Glass-Cutting.— Several factories in the United States are now using electricity for cutting glass. A wire is wound tightly over the glass; this is heated by a current, and on cooling with a dash of cold water, the glass is suddenly and evenly cracked all round. This process, at one time a mere curiosity, or at most a mere laboratory experiment, is proving itself commercially useful in glass factories, and we should be pleased to hear of instances of its practical use in England.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

A COMMON PRICE LIST.

At one of the public meetings of the Electrical Section of the London Chamber of Commerce, Mr. Crompton threw out a suggestion for future consideration which seemed to fall rather flat upon his hearers. This was somewhat surprising, especially as Mr. Crompton's remarks so frequently tread upon the pet conclusions of other folks, and not infrequently ruffle their feathers to the intense delight of those who are outside the circle aimed at, and can therefore appreciate to the full the controversial hitting. Generally, we have found our sympathies and conclusions akin to those of Mr. Crompton, but on this occasion and in this particular direction we are wholly on the other side. No remark, so far as we know, was made, nor have we since heard any unsolicited opinion expressed as regards the suggestion. Perhaps this is because others interpreted the suggestion correctly, and we misinterpret it. If that be so, we contend that the necessity exists for exactly determining and defining what was in the speaker's mind. We cannot pretend to give the exact words, but it may be remembered that the section met a few weeks ago to elect its committee, and that during the counting of the votes a more or less desultory conversation took place regarding the practical work of the section. It was during this discussion that Mr. Crompton suggested the desirability of agreeing upon a common price list, leaving individual manufacturers full liberty as regards discounts. We should not be surprised to learn that the majority of those present were unfamiliar with this method of conducting business, though it is well understood in some branches of trade. One example will perhaps suffice to show its peculiar capabilities. Take the wrought-iron tube trade. We find a standard list adopted, but that purchasers, if they know how to buy, can get as much as 72½ per cent. discount off the list for gas tubes, 67½ per cent. off for water tubes, 60 per cent. off for steam tubes, 57½ per cent. off for galvanised gas tubes, 52½ per cent. off for galvanised water tubes, 42½ per cent. off for galvanised steam tubes, with still greater discounts for the respective fittings. There is a tolerable elastic possibility in a price list of this kind. The real purchaser almost invariably pays a considerably higher price than he would under the ordinary conditions of trade. The purchaser is not up to this particular trick of the trade, and his middleman has him at a disadvantage. Mr. Moneybags thinks the bill rather long, but the subservient presenter shows his price list and dilates upon the cost of materials. Happy ignorance pays, and the happy receiver softly smiles. So far as we know only one technical journal has had the courage to expose this practice, which action has led to its being boycotted by the particular trade mentioned. If such a price list was agreed upon, most undoubtedly

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the manufacturers would be pretty extensive gainers. Their sales are not all to the trade, and when selling direct a 10 per cent. or a 15 per cent. reduction would be thought to be an exceedingly liberal discount. In another trade, where somewhat similar conditions prevail, the instructions usually given to the traveller, and this is vouched for by personal experience, is a limit of 50 per cent. discount. Thus, one buyer who is in the know buys at half the list price; his competitor, a new comer, or not being so experienced, cannot buy so well, and wonders why with more trade, more push, and more energy, his bank balance falls short of that of his rivals. It may not be uninteresting to record the gist of a conversation that took place some years ago between a builder at Brighton and a commercial traveller. *Builder*—Your folks do not manufacture this stuff (terra cotta). *Traveller*—No. *Builder*—What will you take in hard cash to tell me where and how the governor buys? *Traveller* (young but not be caught)—That would hardly pay at any price; you would then buy direct, and probably travel the district against us. *Builder* (bluntly)—Just so; that is what I mean. *Traveller*—Write and ask the governor. Moral—It pays experienced men to find out how to buy to the best advantage, and it is only the most experienced and the one most behind the scenes who knows how and where to get the fullest discount. The travellers, for the benefit of themselves and the house they represent, give as much or as little discount as will induce the order. Is this quite the thing for the development of the electrical industries? Before such a list could be decided upon, however, it would be necessary for the manufacturers to agree more extensively upon the unit which shall regulate the prices on such a list. From one point of view the list would leave individual manufacturers pretty much as they are now. Where the works of one are better organised than at another, and where the prime cost per unit is less, then the same discount off the price list would leave the one with an advantage over the other. In a particular trade the purchaser pays a certain sum, the middleman obtains the goods for half that sum, sometimes even less than this, the manufacturer reckoning that the prime cost is half the sum paid by the middleman, or one-fourth that paid by the ultimate purchaser. Many have tried to break the shackles herein imposed by custom, but have hitherto lamentably failed, mostly so badly as to trouble the Bankruptcy Court, yet few will be bold enough to assert the system to be good. The final customer often does get a *douceur* in the shape of 15 to 25 per cent. discount, and is mightily satisfied thereat. What had Mr. Crompton in his mind when referring to the "list"? If it was on the lines of anything we have referred to above, we hold it would be a move in the wrong direction. The difficulties in the way of such a trade combination in matters electrical are immense, and the result would at least be doubtful. Nevertheless, there is no reason why the scheme should not be considered. Manufacturers may be permitted to know more about what would affect their trade than outsiders, and if they determine to adopt such a scheme, it will only be after having fully and amply considered and discussed the pros and cons of the case.

CORRESPONDENCE.

RE FRIGHTENING WORKMEN.

TO THE EDITOR OF THE ELECTRICAL ENGINEER.

SIR,—Many eminent electricians have visited Mr. Heath's premises for the purpose of seeing Mr. Mordey's transformers, and at the same time have read the caution upon which you comment in your last issue. These gentlemen have expressed their approval of the notice, and as they do, I believe, almost without exception, read your paper, they will probably when reading the article recall to mind their remarks. Those who have had experience in large premises where many workpeople are employed must know how difficult it is to keep them from doing mischief to themselves and their surroundings. The man who would read a notice headed "Caution" with a passing glance might hastily conclude that all electric wires were dangerous, while a careful reader would learn that the mains were to be avoided. Now, for the first man, I say it is better that he should be afraid of all wires, for he would be as thoughtless about touching primaries as he was in reading my notice; but to the careful reader the caution would be quite intelligible.

You say the danger from primaries ought to be infinitesimal. Of course, there should be no such thing as leakage to earth, but the man who believes all things are as they should be has much to learn. I can see possibilities of danger and accident, and am of opinion that one real mishap will do more harm to the progress of electric lighting than very many cautions.—Yours, etc.,

W. T. SMITH,
Clerk of Works to Henry Heath.

December 4, 1888.

REPORTING PROGRESS.

KENSINGTON.

The plant at the Kensington Court electric light station is being added to, in order to cope with increased demand in that district. A Babcock and Wilcox boiler of 250 i.h.p., at 160lb. pressure, is being put down. A further Crompton dynamo, 50 unit machine, will be added. They have at present four Willans engines now fixed; three of these are working, and the fourth will be used to run the new dynamo. Two of these are 45 h.p., and two of 90 h.p., and the new machine is for one of the unused 90 h.p. engines. The dynamos at present working are two 25 unit and one 50 unit. There are between two and three miles of mains now laid, and they are making at the present time a most interesting experiment to determine which of several methods of laying is the best for practical purposes. These comprise portions of Callender's bitumen cable and troughing, brick culvert with bare strips on insulators, brick culvert with cables, small iron pipes with Henley's cables, and insulated cables slung from hooks in the sides of sewers. The bare strips in the brick culvert is evidently the cheapest method with the system of cables in sewers; a great disadvantage is that the men cannot get down to them in bad weather. There are now about 4,000 8-c.p. lamps running on the Kensington circuit, and about 40 Sunbeam lamps of 200 and 300

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c.p. An auxiliary station for the same company, on the same system, is being constructed along the Brompton-road for the Knightsbridge district. Work is proceeding, but the installation will not be ready for supply for some three or four months.

CENTRAL ARC STATION.

As we were the first technical journal to bring the Waterhouse system before the English public, we naturally take some interest in watching the development of this regulator arc system in this country. On looking over the shipping journals of this week we see announcements of large quantities of this plant arriving in England, and indications of the extension of central arc lighting stations are not wanting. As we are going to press we learn that a central station is to be established in London for running 200 Waterhouse arc lamps. The lease has been signed for the site, and work has been commenced. The contract for carrying out this installation is placed in the hands of Messrs. Shippey Bros., Limited.

BRADFORD.

The central installation at Bradford now in course of construction by Messrs. Siemens Brothers is rapidly approaching completion, and it is expected that the supply will be able to be inaugurated by Christmas time. The Town Hall and the Free Library are to be lighted throughout from this source, and the number of applications received by the committee, from business and private consumers, will practically use up the entire power of the installation to its fullest extent from the commencement. So good a start cannot fail to give confidence to customers at greater distances, and we may confidently expect a very large extension of central station lighting in this populous manufacturing town, and in other similar places in the North.

THE MAGNETIC FUNNEL AND SOME OF ITS APPLICATIONS.*

BY A. TANAKADATE.

The paper can scarcely pretend to originality for several reasons. In the first place, my knowledge of the subject is very limited, and I do not know whether or not others have already worked on the same problem. Secondly, the paper itself was once read, or rather talked, in my native tongue before the Physico-Mathematical Society of Tokyō, in Japan, where, however, I did not allow the paper to be published in the society's *Proceedings*, as I thought that I had not yet sufficiently worked out the subject. Under these circumstances, it is with many apologies to the members of this society that I submit to them the results of my still unfinished investigation. Although the subject matter might not be strictly original, I am afraid you will find plenty of originality in my expressions, which is simply due to my imperfect control of your language, and I hope you will grant me your kind indulgence in this respect also.

The definition of a magnetic funnel is, it is the locus of the points in a given magnetic field where the magnetic force in a given direction vanishes. Thus, if V is the potential due to any given system of magnetic matter, and ρ any distance measured in a certain given direction, the mathematical definition of the magnetic funnel is given by the equation:

$$\frac{dV}{d\rho} = 0, \text{ or } F\rho = 0.$$

It might be well to mention here why I called this *funnel*, and how I came to consider such a question. When we take a round solenoidal magnet and consider the points where the forces parallel to the axis of the solenoid vanish, we have a surface very much like an ordinary funnel—a conical surface with an opening at its converging end—and this is a typical surface for bar magnets. Hence we get the name I have applied to these surfaces generally. I was led to take up this question from various practical considerations connected with electrical and magnetic measurements. In almost all the instruments that we are accustomed to use, we measure the quantities required by observing displacements which are prescribed in a certain direction—that is, we limit the number of freedoms of motion to one, which is either a simple rotation about a certain axis, or translation along a certain line. Thus, in most of the current meters and voltmeters the rotation takes place about a vertical axis. In Sir William Thomson's balances it takes place about a horizontal axis, the translation of the sliding weight having nothing to do with the disturbances of the magnetic field; and again, in Sir William Thomson's new ampere gauge and in Ayrton's ammeter we have to deal with a vertical sliding motion, which is simple translation. Hence, in order to eliminate the disturbance caused by a certain distribution of force we need not look for a node where forces in all directions vanish. It is quite sufficient to find such an arrangement that forces along one or two directions should be *nil*. And, generally speaking, this is a better way of eliminating disturbance than by causing nodes, which is critical or unsteady in most cases. Thus, to give a very simple illustration, suppose that we have a steel bar magnet in the vicinity of a tangent galvanometer of the ordinary construction. We need not take the magnet to an infinite distance or out of the room, we have simply and solely to place the magnet in such a position that the earth's directive force is not disturbed by the magnet. One very simple and obvious way is to hold the magnet in a vertical position, with the centre of the bar at the same level as that of the galvanometer needle. The magnetic force due to this magnet is now solely along the direction of the axis of rotation of the needle, and the directive force of the earth's field will not be influenced in the least. This is one special position amongst many which we shall come to discuss presently.

The magnetic funnel being the locus of the points where forces in a given direction vanish, it is evident that the direction of forces on the funnel must be perpendicular to the given direction (which is the only parameter of the funnel) so as to have no components along that line, supposing that there are finite forces in the region under consideration. It thus appears that if two funnels intersect along a curve the directions of forces will all be the same on that curve—viz., perpendicular to the plane which is parallel to the two parameters. From this, one might think that the funnel is the isogonics and the isoclinics of the magnetic chart. But the funnel is different from these curves, inasmuch as the *reference lines* of the isogonics and i oclinics change their direction from point to point—the isogonics are traced with reference to the meridians, which are converging lines as well as curved, and the isoclinics are traced with reference to the level or the zenith, which also change their directions from point to point. Thus the isogonics and isoclinics are of more complicated a nature than the funnels. In a very special case, however, in which the curvature of the earth's surface and the convergence of meridians are negligible, they might be looked upon as funnels. But here we shall find the funnels to become a space loci, and the only other funnels traceable will arise from local disturbances. This brings us to the important relation of funnels to the nature of local disturbances in the magnetic survey of a country.

Imagine, then, a field, as in Fig. 1, where ρ is the direction along which the forces are to vanish. Draw a plane perpendicular to ρ, such as A B, and imagine it to move so as always to remain parallel to itself. Now, in order that there may be a funnel corresponding to the given direction ρ, the moving plane A B must at some point, such as P, be tangent to the lines of force: if there is only one such point, that point is the funnel; if there are many such contiguous points, we have curves or surfaces, which may consist of detached portions. One necessary consequence of this is that the uniform field can have funnels of only one class, and these are planes parallel to the direction of the field. In this case the whole field has no force perpendicular to the direction of the field, and consequently the space itself is to be called funnel.

A funnel, therefore, may consist of a point, or a curve,

* Read before the Physical Society of Glasgow University, Nov. 16, 1888.

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or a surface, or of several detached portions of lines or surfaces.

Another way of conceiving funnels is to follow the equipotential surfaces.

From the equation $\frac{dV}{d\rho} = 0$, it appears that ρ must be tangential to some of the equipotential surfaces, in order that there may be a funnel corresponding to the given direction. Imagine, then, the field plotted out by successive equipotentials, and that ρ touches a certain equipotential surface; then, by carrying about this line (always keeping it parallel to itself) in contact with the surface, we will trace a curve upon the particular equipotential which we selected. If the equipotential surface is a complete synclastic one, we will get one closed curve; if it is an anticlastic one, the trace may consist of one or more curves. Thus, as we pass from one equipotential to another by infinitesimal steps, we will trace out a surface over which there will be no force along the given direction.

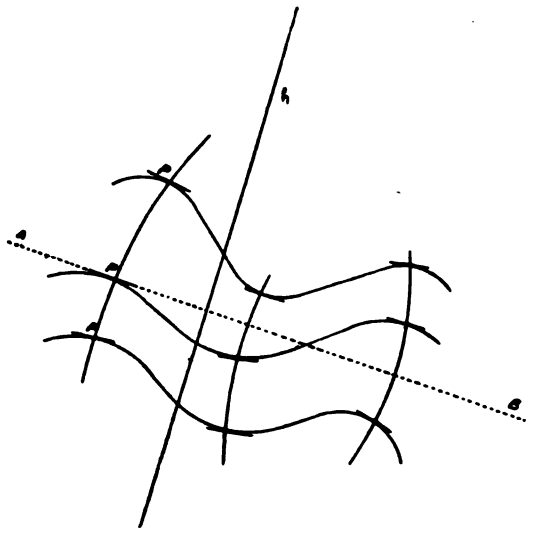

FIG. 1.

Whenever we have a closed equipotential surface, funnels of all parameters must belong to that surface. Hence, in the neighbourhood of a centre of force funnels of all parameters will converge to that centre somewhere, and as, in approaching the point, the equipotentials will become smaller and smaller, we can, in the vicinity of the point, trace all the different funnels as near each other as we please. In other words, all the funnels must touch the centre of action. It is a question whether they will pass through the point or touch the point, and this gave rise to a warm discussion in Tokyō.

Again, at a node the forces in all directions must vanish, so that $\frac{dV}{dx} = 0$; $\frac{dV}{dy} = 0$; $\frac{dV}{dz} = 0$; that is, the condition for a funnel is satisfied for all directions, and all funnels, therefore, must pass through the point. In fact, the funnel may be looked upon as a partial nodal surface, as it fulfils a part of the conditions for a node. Thus the conclusion we come to is, that no three funnels whose parameters are not co-planar can meet except at the centre of action, or at a node. In the former case there will be an infinite force; in the latter, no force.

In any finite magnet the lines of force are closed curves emanating from one part and coming to another, completing the integral curvature, and therefore funnels of any parameter can be drawn. These funnels may be imagined to belong to the magnet just as the lines of forces and equipotential surfaces. At an infinite distance from the magnet, the force arising from a finite magnet will, of course, be zero, and therefore the space at an infinite distance belongs to any funnel and to all funnels. Also, as the field due to any magnet tends to be more and more uniform as we recede from the magnet, the funnel will tend to be more and more straight; that is, all funnels due to a finite magnet in free space must be asymptotic. [Funnels inside Sir William Thomson's marine voltmeter cannot be asymptotic, being in magnetically closed space.]

When a magnet is placed in a uniform field, all the funnels will be modified in shape, in so far as the resultant force at a point now consists of both the external field and that arising from the magnet, the extent of modification depending upon the relative strengths of the external field and that due to the magnet. But whatever the strength of the external field be, and whatever the position of the magnet with regard to the direction of the external field, there will always be one set, and only one set, of funnels which will remain unmodified in shape—namely, those whose parameter lie in a plane perpendicular to the direction of the external field. Along any one of this set the resultant magnetic forces will entirely be in the plane perpendicular to the parameter, with which alone the funnel is concerned. This property of funnels is sometimes useful in experimental researches, and in virtue of this we are enabled to draw funnels to any actual magnet experimentally.

So much for the general features of funnels. I shall now pass on to some particular cases. I have as yet only worked out a very few, and in this respect, therefore, my paper is very incomplete.

The author then proceeded to discuss funnels for the cases of two unlike centres of action and two like centres of action, which may be deduced from the general equation for any number of centres of action, whether they be continuous or detached. This is given by

$$\Sigma \mu \cos r\rho / r^2 = 0;$$

where μ is the strength of pole, r its distance from any particular point on the funnel, and ρ the given parameter. In Cartesian co-ordinates this is

$$\Sigma \frac{\mu \{l(\xi - x) + m(\eta - y) + n(\rho - z)\}}{\{(\xi - x)^2 + (\eta - y)^2 + (\rho - z)^2\}^{\frac{3}{2}}} = 0;$$

l, m, n being the direction cosines of $\rho\lambda$; x, y, z, the co-ordinates of centre of action, whose strength is μ; ξ, η, ρ, the co-ordinates of funnel.

For the case of two centres of action, the line joining the centres may be taken as one axis of co-ordinate reference, and another line perpendicular to this axis and the given direction, ρ, without any loss of generality. When thus considered the equation of the funnel was found to be

$$\sin^2\theta_1 (\cos\alpha \cos\theta_1 + \sin\alpha \sin\theta_1 \cos\phi) \pm \sin^2\theta_2 (\cos\alpha \cos\theta_2 + \sin\alpha \sin\theta_2 \cos\phi) = 0;$$

the double sign applying to the two cases of like and unlike centres of action, where α is the inclination of the given line to the axis of the magnet, θ_1, θ_2 the angles which the radius vectors from the two centres make with regard to the axis, and ϕ the angle which the plane of the radius vectors from the two centres makes with the plane parallel to the axis of magnet and the parameter ρ. The surface was discussed by means of auxiliary functions, from which also a method of finding the asymptotes was shown. Two diagrams of the surfaces were shown, and the various properties were pointed out. Attention was drawn to Gauss's method of disposing magnets in magnetic observatory. He then showed that funnels for the straight current are planes, and also for two parallel currents close together are also planes, and went on to describe how the magnets and currents can be disposed in a laboratory so as to avoid disturbances fulfilling certain given conditions.

Then he described a very simple way of finding the approximate centres of actions which he used to investigate whether the approximate centre depended or not upon the strength of magnetisation, and gave some results of his obtained in Japan.

N.B.—The author wishes it to be *distinctly* understood that the paper was never meant for print in this state. He however, found, it impossible to *resist* the very urgent request of the society to have the thing in their hands, even in the present form. After the introduction, which was the only part written, he had simply to work on the board and talk from his note-book.

The Efficiency of Coal Sheds.—Coal, it is said, loses from 10 to 40 per cent. of its evaporative power if exposed to the effects of sunshine and rain.

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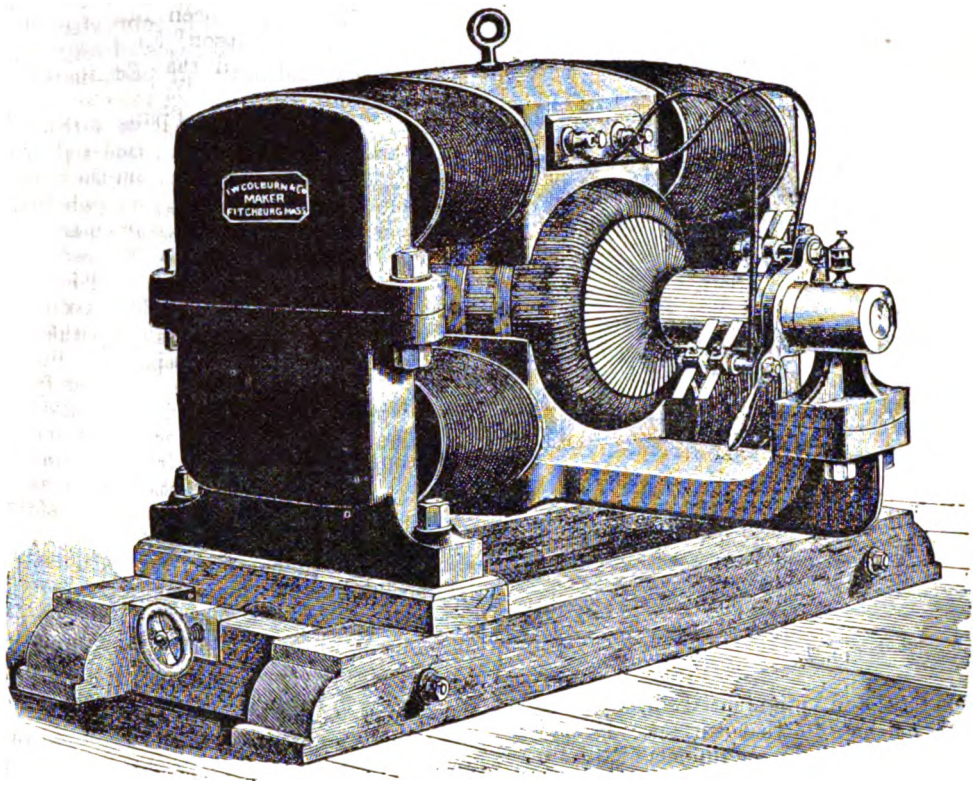
THE COLBURN ARC DYNAMO.

The *Electrical World* illustrates two remodelled dynamos of Messrs. Colburn and Co.—one an arc lighter, the other an incandescent lighter. We herewith show the arc light machine, which our contemporary describes as follows: "It is of the consequent pole type, and has a Gramme ring armature. The field-magnets, as will be noted, have only two points, the upper being bolted to the lower at the neutral point." We confess that our contemporary's description of dynamo machines is, as a rule, of a rather meagre character, and it is difficult for readers to obtain any just conclusion about machines so described; and our immediate object in this note is to suggest that the industry would thank its purveyors to give at least a modicum of information whereby a more definite idea could be obtained of what it is asked to work with.



The Colburn Arc Dynamo.

DESIGNING DYNAMOS AND MOTORS.

BY R. B. OWENS.

The impression still prevails among many mechanical and civil engineers, as well as the general public, that there is about dynamo and motor building something both mysterious and uncertain, and that the designing of a dynamo machine to give a certain predetermined output is for a large part a matter of guesswork. Perhaps the electrical engineers of to-day can pardon this erroneous idea, considering that it was the custom, but a few years ago, among *practical* electricians to roughly guess from the dimensions of some similar machine about what the dimensions should be so as to give the required output, and after the dynamo was built, to change the speed or winding of the field-magnets until the required conditions were fulfilled. If this did not answer, another machine was built until the desired object was attained.

In this short paper I shall endeavour to correct the prevailing impression by showing that all our formulæ of construction are in a very simple manner derived from *experiment*, the only truly scientific method of investigation. To start with an experimental fact, we may state that by a transverse motion of a conductor in a magnetic field the said conductor has an E.M.F. generated in it. This fact was first discovered by Faraday in 1831, and has since become the basis of nearly all electro-mechanical investigations, a more fundamental principle not being needed in practice.

It is also an experimental fact that the same magnet, when placed in different magnetic fields, is acted on by different forces, and a unit magnet pole is defined as that which, placed at a distance of one centimetre from a like magnet pole, repels it with a force of one dyne; hence the intensity of a magnetic field has been taken to be numerically equal to the force in dynes with which a unit magnet pole is acted on when placed in this field. The conventional mode of representing such a field is to draw, or imagine drawn, a number of lines equidistant and so spaced that the number cutting unit area of any plane at right angles to the direction of the lines numerically equals the intensity of the field. This mode of representation is very convenient, as will be seen further on.

Physicists observing the E.M.F. in the moving conductor to vary as its length, velocity, and the intensity of the field in which it moved, and also being desirous of establishing some general system of units, most naturally define unit E.M.F. as that which is generated in a conductor one centimetre in length, moving with a velocity of one centimetre per second, and in a field having an intensity of one dyne, the motion being a right angles to the lines of force. Unit current is defined as that which, flowing in a conductor one centimetre in length, at a distance of one centimetre from unit magnet pole, acts on this pole with a force of one dyne.

The question which next presents itself after defining unit E.M.F. and unit current is the determination of the energy of a current C flowing under a difference of potential or E.M.F., E. To fix ideas, suppose we have a large metallic sphere charged with a certain amount of positive electricity, and also a small gilded pith ball charged with unit quantity of positive electricity. Now, according to Sir William Thomson, the electrical potential of the sphere numerically equals the amount of work done in bringing the pith ball from an infinite distance (when, of course, the force between the sphere and ball is zero) up to the sphere. If, however, instead of starting from an infinite distance we had started from another sphere having a different potential from the first, the mechanical work expended in transferring our pith ball from the one to the other would numerically equal the difference of potential between the two spheres. It is also evident that had the

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pith ball contained two, three, or more units the mechanical energy expended would have increased in the same ratio. Hence, it follows that the mechanical energy required to transfer q units of electricity from a sphere or point where the potential is p_1 to a sphere or point where the potential is p_2 (p_2 being greater than p_1), is $q\,(p_2 - p_1)$; and the result would not be altered if, instead of the transfer taking place by the aid of our pith ball, carrying a definite amount of electricity q, it were to take place by means of a wire carrying a continuous current, since the latter may be considered as a succession of pith balls. Hence, we see that the power of a current C flowing under a difference of potential E is E C. If E is measured in volts instead of absolute units, and C in amperes instead of absolute units of current, then the product E C is measured in watts; one watt = 10^7 ergs per second.

Having these preliminary considerations clearly in mind, the whole theory of dynamo and motor construction may be easily and simply evolved. Consider a single wire, of length d, on the armature of a dynamo, the wire moving at right angles to the lines of force with a velocity v, and in a field of intensity, H. The E.M.F. generated in this wire is, from the definition of unit E.M.F., evidently $E = H\,d\,v$. If the diameter of the armature is 2 r, then at a speed of n revolutions per minute the velocity,

$$v = 2\,\pi\,r\frac{n}{60}\text{; hence, } E = 2\,\pi\,r\,H\,d\,\frac{n}{60}.$$

But $2\,r\,d$ is the total space swept over by the wire, and $2\,H\,r\,d$ is the total number of lines of force passing through the space. Calling this number Z, we have for the maximum E.M.F. the expression $E = \pi Z\frac{n}{60}$. But since during one-half revolution the E.M.F. decreases from maximum to zero and increases again to maximum, it becomes of importance in practice to determine that mean E.M.F. which, acting for the same time as the variable one, will cause the same amount of electricity to flow through the circuit.

This may be done as follows: Let the position of the wire at any moment be defined by the angle α which it makes with the line joining the poles of the field-magnets, and in a time $d\,t$, let it advance through an angle $d\,\alpha$. The quantity of electricity which flows through the circuit of resistance, R, is evidently $dq = \frac{H\,d\,v\,\sin\,\alpha\,dt}{R}$.

But $v = r\,\frac{d\alpha}{dt}$; and, therefore, $dq = \frac{H\,d\,r\,\sin\,\alpha\,d\alpha}{R}$.

Integrating between the limits zero and π, we have $q = \frac{2\,H\,d\,r}{R}$. The time of this transfer of q units is $\frac{\pi\,r}{v}$ and had a constant E.M.F., E', acted for this time the quantity transferred would have been $\frac{E'\pi r}{R\,v}$. If this quantity is to equal q, E' must be considered the average E.M.F. sought, its value being given by the equation $E' = \frac{2}{\pi}\,H\,d\,v = \frac{2}{\pi}\,E$. Substituting for E its value, $\pi\,Z\,\frac{n}{60}$, we have, as the average E.M.F. generated in one turn of wire on the armature during one-half revolution the very simple expression $E' = 2\,Z\frac{n}{60}$. Supposing the armature wires to be N in number instead of one, at any moment, therefore, there will be but $\frac{N}{2}$ joined in series. We have as the total armature E.M.F. $E_a = 2\left(\frac{N}{2}\right)Z\frac{n}{60} = N\,Z\frac{n}{60}$. This value of E_a is given in absolute units; to reduce to practical units or volts, we simply write $E_a = N\,Z\frac{n}{60}10^{-8}$. As showing how the dimensions of the armature affect the result, the equation is often put in the form

$$E_a = 2\,r\,d\,H\,N\,\frac{n}{60}\,10^{-8}.$$

Now, from this last equation it will be seen how simple and accurate is the predetermination of the E.M.F. which will be generated in an armature having upon it any number of wires, and revolving at any speed, *having given the intensity of field in which it revolves.*

But perhaps the most difficult problem to be met with in this connection is the forming of some rule by which the intensity of field H may be determined from the constructive data of the machine, such as the amount of wire on the field-magnets, their length, weight, etc. And it has only been in the last two or three years since designers of dynamos and motors have taken hold of and utilised the conception of a magnetic circuit and resistance that really practical results have been reached. However, after the work of Dr. Hopkinson, Mr. Kapp, and some others, I think it may be said that we have formulæ sufficiently accurate for all practical purposes. Those I shall give are taken mainly from several papers by Mr. Kapp.

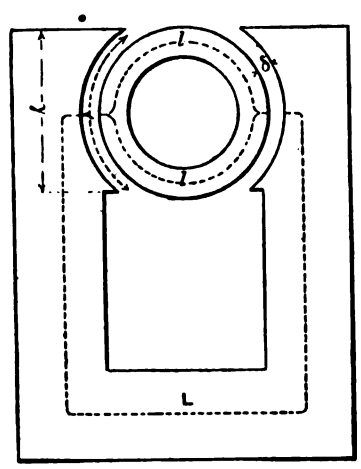
It is evident after what has been said concerning the generation of an E.M.F. in an armature, that the proper function of the field-magnets is to produce lines of force which pass across the armature coil, making H as large as possible with the least expenditure of magnetising power, questions of magnetic moment having no bearing on the subject whatever.

Magnetising power is measured in ampere-turns, and both experiment and theory show that the effect is the same whether we use many turns of fine wire and a small current or a few turns of stout wire and a large current, so long as the product of amperes and turns remains constant.

Experiment also shows that for low degrees of magnetisation the E.M.F. produced in the armature is very nearly proportional to the magnetising power P applied to the field-magnets, and as E.M.F. and the number of lines of force which pass across the armature core are always proportional, we find in this case Z varies as P.

This relation is otherwise expressed by introducing the conception of magnetic resistance, according to which there is in every magnetic circuit a passive force opposing the creation of lines. The number which are, however, created is the quotient of the magnetising power and this resistance. Calling the latter R, we have $Z = \frac{P}{R}$.

To illustrate, suppose we have an ordinary two-pole dynamo, as in the accompanying figure, the dotted line



representing the magnetic circuit. Now let us denote the average length of the magnetic circuit within the field-magnets by L, the cross-section of magnets by M, length of armature by b, the arc spanned by either pole by λ; distance between polar surface of magnets and external surface of armature core by δ, also calling l the average length of the magnetic circuit in the armature, which we shall suppose to have a cross-section, μ. Should the analogy with Ohm's law hold good—that is, if magnetic resistance varies as the length of the circuit and inversely

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as its cross section—we should expect R to be proportional to $\frac{L}{M}$, $\frac{l}{\mu}$ and $\frac{2\delta}{\lambda b}$; and, in fact, Mr. Kapp has found, after numerous experiments with machines of this type, made of well annealed wrought iron, that the number of lines which pass through the armature, say, up to 60,000 lines per square inch, is represented by the formula

$$Z = \frac{6000\ P}{1440\frac{2\delta}{\lambda b} + \frac{l}{\mu} + \frac{2\ L}{M}}.$$

Also, for cast-iron magnets,

$$Z = \frac{0{\cdot}8\ P \times 6{,}000}{1{,}800\ \frac{2\delta}{\lambda b} + \frac{l}{\mu} + \frac{2L}{M}}.$$

These formulæ are not, however, absolutely correct, and it is doubtful whether any formula rigorously true for all degrees of magnetisation will ever be found owing to the great difference in chemical composition of different specimens of iron. Nevertheless, many electrical engineers of to-day can predetermine the output and efficiency of their machines to within 2 or 3 per cent., which is, perhaps, all that is required in practice.

To take a practical example, suppose it is required to build a dynamo to give a current of 100 amperes at 110 volts pressure, and to have an efficiency of 90 per cent. Of the 10 per cent. lost in the machine we will allow 4 per cent. for the field-magnets, 3 per cent. to armature, and 3 per cent to eddy currents and friction at bearings. The energy delivered to the external circuit equals $E\ C = 110 \times 100 = 11{,}000$ watts; and denoting total amount of energy delivered to the machine by X we have,

$$\frac{90}{100}X = 11{,}000. \quad \therefore X = 12{,}222{\cdot}2 \text{ watts.}$$

Putting y for the magnetising current of the field-magnets, we have $Ey = X \times {\cdot}04 = 488{\cdot}8$, whence $y = 4{\cdot}8$ amperes.

The total armature current $C_a = C + y = 104{\cdot}8$ amperes.

The total armature E.M.F. $E_a = \frac{X}{C_a}$ + counter E.M.F. produced by eddy currents in armature core and field-magnets. The latter being very small and difficult to estimate, we shall write $E_a = 117 + 3 = 120$ volts. Energy lost in armature equals $C^2 R = {\cdot}03 \times X = 366{\cdot}6$ watts. Therefore, R = ·033 ohm—that is, the resistance of the armature must be ·033 ohm. The resistance of the magnetising coils equals $\frac{E}{y} = 23$ ohms.

Let the type of machine be that shown in section in the diagram—that is, a Gramme ring armature and horse-shoe field-magnets. Now, upon examining the equation, $E = 2\ r\ d\ H\ N\frac{n}{60}$, it will be seen that a number of armatures of entirely different proportions may generate the same E.M.F. For instance, one armature may have twice as many windings as another, and will, therefore, require only half the field intensity or half the speed, or it may have half the diameter, but twice the length; or it may have many other combinations of speed, diameter, length, intensity of field and number of windings, yet still give the same E.M.F., the best dimensions in any case being determined by the limiting conditions. In the present instance let us take the length of the armature as 8in. and depth radially 2½ in.; then the length of one convolution will be 21in. Also let us limit the number of layers on the armature to two. The resistance of the wire on the two halves of the armature is calculated for ·033 ohm, and being joined in multiple arc, the resistance of one half of the armature must be ·066 ohm. Now, suppose we use for the armature a No. 5 (S.W.G.) wire, which has a diameter of ·212in. and a resistance of ·0002326 ohm per foot, or ·00040705 ohm per convolution. The number of convolutions on one half the armature will be $\frac{·066}{·00040705} = 162$, which also equals the number on the whole first layer. Allowing ·015in. for insulation, the radius r of the armature equals $\frac{162 \times ·237}{2\pi}$ minus the radius of wire; this gives $r = 6$. Experiment shows a good value for the field intensity H to be about 50,000 lines per square inch, and substituting these values of r, d, N, H, and E in the equation for E, we have:

$$120 = \frac{2 \times 6 \times 8 \times 188 \times 50{,}000 \times n}{60 \times 100{,}000{,}000}; \text{ whence } n = 463.$$

That is to say, an armature of the above dimensions in a field having an intensity of 50,000 lines per square inch must be driven at a speed of 463 revolutions per minute to have generated it in an E.M.F. of 120 volts, 110 of which appear at the terminals of the machine, the other 10 being consumed in overcoming the resistance of the armature and by eddy current.

Now we arrive at the second part of the problem—namely, the determination of the number of ampere-turns required to produce the intensity of field H = 50,000. In the formulæ

$$Z = \frac{6{,}000\ P}{1{,}440\frac{2\delta}{\lambda b} + \frac{l}{\mu} + \frac{2L}{M}},$$

δ equals the air space plus the thickness of binding wire, plus $2 \times ·237 = ·7$in. Making the arc spanned by either pole ·35 of the external surface of the armature, we have $\lambda = 14{\cdot}2$in.; also $b = 8$in., $l = 14{\cdot}9$in., and $\mu = 20$ square inches. Let the diameter of the magnet cores be 7in.; then their cross section M will be $\pi \times 7^2 = 155{\cdot}46$ square inches. Also, if we make the magnet limbs 14in. long and the yoke 24in., then the average value of L will be 66in. Substituting in the formula we have

$$2 \times 6 \times 8 \times 50{,}000 = \frac{P}{1{,}440\frac{1{\cdot}4}{(14{\cdot}8){\cdot}8} + \frac{14{\cdot}9}{20} + \frac{132}{155{\cdot}46}};$$

$P = 15{,}153{\cdot}8$.

Now, as the current through the field-magnets is $\frac{110}{23} = 4{\cdot}8$ amperes, the number of turns on the magnet must be $\frac{15{,}153{\cdot}8}{4{\cdot}8} = 3{,}157$; and on each magnet limb $\frac{3{,}157}{2} = 1{,}578$. The average length of one turn may be taken to be $\frac{2\pi \times 75}{12} = 3{\cdot}9$ft.; and of the wire on both limbs $3{\cdot}9 \times 3{,}175 = 12{,}312$ft.; so that the resistance per foot must be $\frac{23}{12{,}312} = ·0018$ ohm. Referring to a table of resistances we find No. 15 S. W. G. has the nearest required resistance.—*Electrical World* (New York).

CONDENSERS AS CONVERTERS.

According to our American contemporary, the *Electrical World*, Mr. W. J. McElroy has patented an invention of a condenser to be used in place of the transformer in alternate current distribution. From the description given by our contemporary, Mr. McElroy proposes to transform down by proportioning the size of his condenser plates. If it is desired to carry on the main line a current of 1,000 volts and to supply current on the consumption lines at 100 volts, then the size of the condenser sheets at one side must be to those at the other side as one to ten—the idea being that as the current alternates the induced charge at the instant of reversal at each alternation is free to flow over a surface 10 times larger than that on which it originally held, and the potential therefore falls to one-tenth the original figure, and the E.M.F. at which it can be utilised from this end of the condenser will be correspondingly reduced below that of the inducing current. We confess to have had some faint idea of the laws governing the action and capabilities of the condenser, and Mr. McElroy's improvement hardly seems consistent with what is known on the subject. It may be that we are unable to comprehend the

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real merits of this improvement, but it seems to savour somewhat of the putting of a bundle of wires in an external circuit, and saying that the bundle is going to play a very important part in the economy of the circuit other than reducing resistance.

We cannot well be mistaken in the ideas suggested by Mr. McElroy, because our contemporary has illustrated them. It might perhaps be well to ask in what way it is supposed the unopposed portion of the larger condenser sheets act as condensers, and it may be that the inventor has fallen into error in supposing that the interposition of a condenser into any circuit has no effect upon that circuit. We would advise a careful consideration of the papers of Mr. Blakesley, and of the discussions at the Physical Society, as well as Mr. Sumpner's contributions to the literature on this subject, when it will be seen that the whole question has been, we may say, exhaustively considered. There is still, however, one question which it would be well to work out before proceeding to attempt any practical work in this direction, and that is the size of the condenser that would be required to replace the alternators. We believe that Mr. Kapp long ago worked this question, and found the idea far from practicable.

AMERICAN FUN.

The following *jeu d'esprit* comes to us with others from America through our ever genial friend, Mr. H. Edmunds, who always seems to be in the swim when fun abounds: Another and a better one will follow next week:

MYSTIC AND ELECTRIC ORDER OF KAZOOS.

VERMILION CIRCUIT, No. 0.

To all to whom these presents may come:

GREETING—This is to signify that in consideration of your notorious character, you are mysteriously and obscuriously called to attend a meeting of Vermilion Circuit, No. 0, M. E. O. K., to be held in S. E. Turrett, this Thursday afternoon, at four o'clock for the purpose of promulgating with due magnificence the observances of the order.

Fail not at your peril,

By order of the

MYSTIC CHIEF MAGNET.

MOST NOTORIOUS MEMBERS OF VERMILION CIRCUIT, No. 0, M.E.O.K.

It is with a bosom wrung to the core by intense and powerful currents of agony that My Most Attractive Majesty the Soaked and Saturated Chief Magnet, before whom even Jumbo and the mammoth bend their lines of force, approaches the shocking duty of temporarily breaking the circuit of the most fallacious M.E.O.K.

As is customary upon such ruptures, and in accordance with Ohm's law, the Chief Magnet is constrained to discharge his extra current in a spark of verbose illuminosity.

To part with my keeper and my able assistants, the Incubator and His Nibs the Electric Pen, and to sever connection with the main circuit of High Potential Kazoos, requires a gyratory movement of my computator which can only be produced by a heavy supply of that Electricious Energy which has been so efficiently stored within striking distance of the Inquisition Building.

Now, Most Absorbent Branches of the Circuit of Kazoos, by the power in me charged, and under the influence of the Cranklin Kazoos—to—toot, I will briefly condense the unimportant work accomplished by our self-repulsive body.

We have primer-ily reacted upon, and induced within, the young idea electrifying principle that it is nobler to be a one horse-power professor than a 2,000 volt practitioner, besides quadruplexing his perplexities and increasing his capacity for ignorance.

We have sparked and shocked the d— cells of the highest schools.

We have magnetized the highly-charged but lowly-paid professors to a degree that leads us to confidentially trust that subsequent generations will be even more misled than the present.

We have in the field of rival publications, whose misinformation is peculiarly inexact, disseminated completely unreliable knowledge amongst the confiding public; and toward the attainment of this commendable end we have been violently aided by the scienticks from the rural cemeteries.

We have discouraged the electrikal inventor to renewed efforts in reversed directions. We have, in short, conferred upon the stewdents of science multifarious benefits which time will not permit us to enumerate. Already the current is weakening, and we feel our lines of force collapsing.

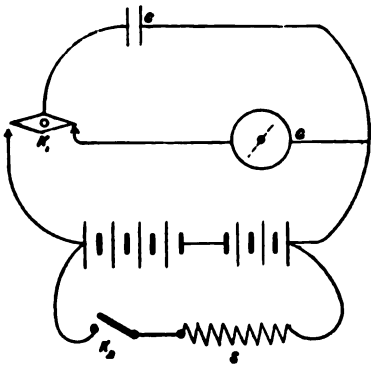
We thank our dishonourable circuitous body for its inhuman efforts in behalf of an electro-agnostic public, and we are indebted to numerous committees for illustrating practically the methods of destruction to be avoided.

Trusting that the continuity of the circuit of the M. E. O. K.'s may soon be re-established, and my keeper restored to me I now, in a spirit of true kazooviality, declare the imposition disclosed.

INTERNAL RESISTANCE OF ACCUMULATORS.

The measurement of the internal resistance of a battery of accumulators being difficult in consequence of the very small resistance and high E.M.F. of the cells, we have extracted from *Revue Internationale de L'Electricité* the following method communicated to it by M. Dallas, which, if not new, is good.

Take, by preference, an odd number, n, of cells, and arrange so that $\frac{n+1}{2}$ are opposed by $\frac{n-1}{2}$; then, while the internal resistance of the battery is the sum of the resistances of the cells, the E.M.F. is that of a single cell. Join up the battery, as shown in the annexed diagram, in which C is a condenser, G a galvanometer, K_1 and K_2 two keys, and S a convenient resistance.



The galvanometer should be ballistic, and the resistance S adjustable, in order to make the experiment as accurate as possible.

Now, press down the key K_1, and on release take the deflection on the galvanometer D; next depress both K_1 and K_2, and releasing K_1 before K_2 take the deflection on the galvanometer d. Then, if R be the internal resistance of the battery $\frac{R}{R+S} = \frac{\sin \frac{1}{2} d}{\sin \frac{1}{2} D}$ or $R = S \frac{\sin \frac{D}{2} - \sin \frac{d}{2}}{\sin \frac{d}{2}}$.

If D and d are small, $R = S \frac{D-d}{d}$. To be most accurate, S should be so adjusted that $d = \frac{D}{3}$.

Electricity and Boiling Water.—The peculiar effects of the electric discharge on dust have been well shown by Dr. Oliver Lodge in connection with the deposition of lead fume. M. Soret, of Geneva, shows a similar phenomena in connection with boiling water. He places a platinum cup full of water in a dark chamber, and connects it with one pole of an influence machine, whilst the other pole is fixed at any convenient distance above the surface of the water. The water is then heated with a Bunsen burner, and its surface strongly illumined by an arc light. As the water boils, the vapour is distinctly visible in the luminous beam; but on setting the machine to work it is reprecipitated on the edges of the cup. By placing the upper pole sufficiently near the surface of the water the whole of the steam disappears, being precipitated as rapidly as it forms, although the water still continues to boil.

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COMPANIES' MEETINGS.

THE MAXIM-WESTON ELECTRIC LIGHT COMPANY.

An extraordinary general meeting of the Maxim-Weston Electric Company, Limited, was held on Monday last, at the Cannon-street Hotel, for the purpose of considering resolutions to be submitted by the Board for a reconstruction of the Company. Mr. John Marks presided.

The **Secretary** (Mr. Samuel J. Boyce) having read the notice convening the meeting,

The **Chairman** said part of the business they were met to transact was, he understood, to be of a contentious character and part of a non-contentious character. With regard to the first resolution—that the Maxim-Weston Electric Company be wound up voluntarily, and certain people appointed as liquidators—he purposed asking the meeting to be good enough to divide that into two resolutions, for the reason that he thought they would be unanimously agreed upon the necessity for winding-up, while he understood there would be some opposition to the appointment of liquidators, Mr. Hugh Watt having issued a circular to some shareholders, in which he advocated the appointment of "a high-class professional liquidator, so that in sale or reconstruction shareholders will be protected by the court." Shareholders would recollect that at the last meeting they had for the reduction of the capital, it was arranged that unless 80,000 of the unissued shares were applied for, the Directors should make no allotment. These 80,000 shares were not applied for; the applications were for only about 25,000. The Directors could not, therefore, because of their engagement to the shareholders, proceed to make any allotment; but they returned the money paid on application. The result was that the capital necessary for carrying on the business was not provided, so that there was no help for it but to wind up voluntarily. Therefore, he would now move: "That the Maxim-Weston Electric Company, Limited, be wound up voluntarily."

Sir Henry Hoare seconded the motion.

The **Chairman**, in reply to a shareholder, said the manner in which the shareholders' money had been disposed of in the past was at present before a court of law, and he should not feel justified in anticipating the matter. The subject had not been lost sight of by the Directors.

The resolution was then put and carried, with one dissentient (Dr. Griffiths).

Mr. Hirsch next moved, "That Mr. John Marks, of 113, Great Russell-street, W.C., Mr. J. M. Klenck, of 42, Bishopsgate-street Within, E.C., and Mr. Louis Swaby, of 23, Churchfield-road, Ealing, be and they are hereby appointed liquidators for the purpose of such winding up." He remarked that they all knew the gentlemen named thoroughly well, and were sure they would do the best they could for the shareholders. The gentlemen they had elected as the new Board of Directors had already done a great deal for the Company, first of all in staying the action then proceeding, and, secondly, in seeing that the claims they had against Mr. Watt were brought forward.

Sir H. Hoare said he was in a position of knowing nothing about this Company. He had called two or three times, in the five years he had held shares, at the late offices of the Company, but there had always been but one response to his questions—they were very short of money. At last they had come to the pass of having no money at all. He asked that he might be given some information about the gentlemen it was proposed to appoint liquidators, and what they had done for the Company. Evidently Mr. Watt was not in very good odour among the shareholders, and in the opinion of some, at any rate, he had mismanaged their affairs. Would anyone tell him what was the position of the Company and what was alleged against Mr. Watt?

The **Chairman** said it was his intention to say something on that point in moving the next resolution.

Mr. Hodge seconded the motion.

Mr. Ramsden pressed for information concerning the proposed liquidators.

Mr. John Newton said he would tell the shareholders what he knew of the liquidators. As to Mr. Watt, he had the management of the Company for five years, and when he left there were no funds in the till, and no business doing of any moment. Mr. Watt took £1,200 a year for his services; he told them at one meeting that he had reduced the amount to £1,000, but, as a matter of fact, he took £1,200, and he not only took that salary, but he took a commission on business introduced by himself. He (Mr. Newton) contended that no Director could legally do that unless he had the authority of a resolution carried by the shareholders. As regarded the proposed liquidators, he, as a member of the investigation committee, was thoroughly convinced that it was not possible to select a better man than Mr. John Marks, or one who would look after their interests with greater zeal and more uprightness. That was his opinion of Mr. Marks—he was satisfied that he was a sound and good man of business. As for Mr. Klenck, everyone who knew him would agree in the opinion that if there were a keen man for investigating matters, that man was Mr. Klenck, and they could not do better than give Mr. Marks the assistance of Mr. Klenck's investigating power and energy. He did not know Mr. Swaby personally, but had witnessed the persistent and plucky way in which he had put forward his contentions and withstood the attacks made on him by Mr. Watt, and they wanted someone imbued with that feeling to look after the interests of shareholders who put their money in this investment on the faith of Mr. Watt's ability and integrity.

The **Chairman** said, when the present Directors took office they found at the bank a balance of £2. 16s., while they had writs for hundreds of pounds flying over their heads from the creditors of the Company. They went to the bank and asked for an overdraft of £1,000. It was refused as far as the Company was concerned, but lent them on the personal security of the Directors, and that £1,000 was expended in the payment of debts contracted under Mr. Watt's management. The next thing the Directors did was to employ chartered accountants to thoroughly investigate the accounts. And what did they find? He said, deliberately, that the last balance-sheet Mr. Watt issued to the shareholders was absolutely false. It showed a false profit, on which Mr. Watt had taken 5 per cent. commission. Not only that, but there were sales entered in the books as bona fide, and which they found were bogus sales; large profits arising from these being shown on the books, but on which, in reality, the Company made a serious loss. Mr. Watt had taken 5 per cent. commission on those. It was Mr. Watt's management, or, rather, mismanagement, which had brought them to the present position, yet he sent out a circular now in which he said: "As the holder of 8,000 shares I cannot allow this Company to go to ruin without an effort to prevent it." He took credit for being the holder of 8,000 shares, but who had the Directors to thank for that? as he had actually sold 6,500 of those shares, but the Directors refused to recognise the transfer, and they were now suing him for £4,600, which, they alleged, he improperly extracted from the coffers of the Company. The Board had no right to anticipate what the result of the action would be; but he might say they felt very confident in the matter.

The resolution was then put, and carried with three dissentients.

The **Chairman** said if the third resolution were carried, *the others* would follow as a matter of course, and he would *therefore combine* the whole of the other resolutions, and move: "That the liquidators be and are hereby authorised to sell and transfer, subject to due provision being made for dissentient shareholders (if any), all the letters patent, business, property, machinery, plant, assets and effects of the Company, whatsoever and wheresoever, to a company to be formed with limited liability, under the Companies Acts 1862 to 1886, with a capital not exceeding £75,000, divided into 500,000 shares of 3s. each, for the purpose, amongst other things, of taking over and working the property of this Company upon the following terms: (*a*) The new company shall pay and discharge the debts and liabilities of this Company, and also the expenses of and incident to the winding up of the same, and of the incorporation of the new company, and of the sale and transfer by the liquidators of the assets and liabilities of the Company to the new company. (*b*) The new company shall allot and issue to the liquidators, or as they shall direct, 312,000 shares in the new company of 3s. each, upon each of which there shall be credited the sum of 2s., a proper agreement being filed with the registrar of joint stock companies before the issue of such shares, so that the same may be liable to the payment of 1s. per share and no more. That the liquidators be, and they are hereby, authorised and directed to procure to be allotted to every member of this Company requiring the same one share in the new company, with 2s. credited as paid thereon, for and in respect of every share held by him in this Company, provided always that to entitle the members of this Company to an allotment of such new shares, application must be made for the same in writing within 10 days after the posting of a notice informing him of his right to apply for the same, addressed to his registered address in the books of the Company. If no such application is received by the liquidators within the time limited as aforesaid, the right of such members to receive such proportion of shares shall be absolutely at an end, and the liquidators, in order that the necessary capital may be promptly raised and the liquidation closed, shall dispose of any shares refused or not applied for as aforesaid to any person or persons, whether *shareholders* or not, at such price (if any) and upon such terms as the liquidators may think fit. That the liquidators be, and they are hereby, authorised to continue the business of the Company pending the transfer thereof to the new company, and to consent to the registration of the new company by the same or a similar name to that of the Company." The Chairman traced the circumstances which had brought about the necessity for winding up the Company. Mr. Watt, he said, confidently anticipated that they would not be able to carry on the affairs of the Company without him, and as soon as he found they could do so started an action in the Court of Chancery for the compulsory winding-up. The Court decided that as there were matters of accounts between the parties the petition should be dismissed on the payment into the bank, in the joint names of the respective solicitors to the Company and Mr. Watt, of the sum of £500, to abide the result of the action that Mr. Watt would commence against the Company or the Company would commence against him. That money had been paid, and the Directors had had to find it out of their own pockets in order to keep the Company going. The Chairman then dealt with the circular, dated October 2, issued by Mr. Watt, and characterised it in strong terms. The suggestions made by Mr. Watt, he declared, contained not a shadow of truth. Mr. Watt had declared that the present scheme was "an absolute form, which eminent counsel had advised him was illegal"; but it was precisely the same line of action as that pursued by Mr. Watt himself, in converting the New Chile Company into the Yuruari Company. He pointed to the results of the actions against Mr. Swaby and Dr. Cameron, to show that Mr. Watt had been unfortunate in his legal advice hitherto. The Directors, he said, were confident as to the future of the Company if this scheme were carried out. They would have a capital of £15,600, which would be ample to continue working the Company. He regretted to say that in the last month they had had to let contracts slip by that would have brought them in a profit of £1,500, which would have been sufficient of itself to have paid a dividend of 2½ per cent. That was an order entirely unsolicited, and if they could do that during the past month, surely with eleven months in hand they could have earned sufficient to have paid a handsome dividend by the end of next year. The prospect for electric lighting had never been so promising as at the present time, and he had every confidence that if the present scheme were carried out, and they were thus supplied with the necessary capital, they would be able at the end of the year to put before the shareholders a balance-sheet which would show a very fair dividend.

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He asked the shareholders to carry the scheme unanimously, and remarked that under a forced sale they would get nothing.

Sir Henry Hoare asked what the assets were valued at.

The **Chairman** replied £12,000, but added that by forced sale they could not expect to get more than a quarter of that amount.

Mr. Klenck seconded the motion, and said he thought the scheme was the only way the Company had out of its present difficulties. The Directors had made the scheme as light as possible for the shareholders, and if they could not find 1s. a share to save their property it would be very hard. They had very valuable patents, and must not lose them if they could help it. They had taken the fictitious value off their machinery, and the capital would give them that credit and means which it was necessary for them to have at their backs before they accepted any contracts.

Mr. Stent described some negotiations his firm had with Mr. Watt for lighting a certain large town, and said he would tell them why they fell through. They found that Mr. Watt nominally lent, but actually paid, to their engineer a sum of money to induce him to guarantee, as far as his influence went, that he (Mr. Watt) and the Maxim-Weston Company should have that contract. The day that came to their knowledge they closed their intercourse with Mr. Watt. The deduction which his colleagues and himself drew from their intercourse with Mr. Watt compelled him to confirm and support to the utmost of his ability the information which had been expressed there to-day as to the conduct of the Company under the old directorate.

Sir H. Hoare said he had come to the meeting with what Mr. Gladstone would call a perfectly open mind, and he thanked the Chairman for his extremely candid and explicit statement. He thought the Company would prosper in the future, and hoped to give it all the support in his humble power.

Mr. Michael Abraham said he had but recently become Mr. Watt's solicitor, and, so far, had not acted unsuccessfully in his behalf, so that the Chairman's remark did not apply to him. He was not there to throw any difficulty whatever in the way of this reconstruction, it being the view of the shareholders that the Company should be reconstructed; but he wished to put one or two questions, which would be an assistance to the liquidators in carrying it out. It was necessary, from a legal point of view, that certain things should be considered. The first question was, who were to be the Directors of the new Company, because three of the present Directors were to be the liquidators? He presumed the three liquidators would also be Directors, therefore they would be the sellers and purchasers of the property. Then, what were they getting for the property?—300,000 shares with 2s. paid up. What provision was being made for dissentient shareholders? He prophesied they would have a large number of dissentient shareholders. They had fixed the value of the shares at 2s., and they would have to pay 2s. a share to each shareholder who dissented.

The **Chairman**: We differ from you there.

Mr. Abraham said he should demand the payment of 2s. a share on behalf of every shareholder he represented. He asked what were the liabilities of the old Company which they would have to discharge, and what provision had been made for meeting them? Also what provision had been made as to the costs of the liquidation? With regard to Mr. Watt, very hard words had been said against him, and if he had been there he would have resented those words. Seeing the feeling of the meeting, he thought he had acted prudently in staying away, for had he been present they might have had a scene of confusion that would not have been creditable. He complained of the references that had been made to the legal proceedings, seeing they were *sub judice*, and said Mr. Watt would account for every farthing of the Company's money.

Mr. Spicer asked if there were any liability attaching to the assets.

The **Chairman** said the liabilities were as nearly as possible covered by the book debts, and they believed every bad debt had been taken out. Therefore, their assets were unencumbered. With regard to Mr. Abraham's questions, the liquidators would be Directors of the new Company. The dissentient shareholders were expressly provided for under the Joint Stock Companies Act, under which the value of the shares was to be fixed by arbitration. As to the dissentients, the Directors had friends at their backs who were willing to take shares to the extent of 100,000, if the Directors could supply them, so they did not feel at all alarmed at Mr. Abraham's saying they would have a large number of dissentient shareholders.

Mr. Abrahams: I say the arbitrators will fix the value of the shares at 2s.

The **Chairman**: We do not agree with you. The Chairman, continuing, said it would be the duty of the liquidators to provide for the dissentient shareholders. The expenses of the liquidation would be reduced to a minimum. The liquidators were thoroughly conversant with the affairs of the Company, whereas "a high-class professional liquidator" would have to be made acquainted with them, and would charge for his time. The amount of the liabilities of the old Company would range from £2,000 to £2,500, and they had book debts to meet them.

The resolution was put from the chair, and declared carried with three dissentients. The Chairman added that all the resolutions had been carried by more than the necessary three quarters majority.

A vote of thanks was accorded the Chairman, and the proceedings terminated.

Eastern Telegraph Company.—The receipts of this Company for November were £59,862, as against £53,454 for the same period of 1887, or an increase of £6,408.

Direct Spanish Telegraph Company, Limited.—For the month of November the receipts of this Company show a decrease of £165 as compared with the corresponding period.

NEW COMPANIES REGISTERED.

Antofagasta (Chili) and Bolivia Railway Company, Limited.—Registered by W. C. Slaughter, 18, Austinfriars, E.C., with a capital of £1,450,000, in shares of £100 each. Object: to enter into and carry into effect, either with or without modification, two agreements purporting to be made between the Compania Huanchaca de Bolivia of the one part and the Antofagasta (Chili) and Bolivia Railway Company, Limited, of the other part, and to purchase or otherwise acquire, construct, equip, maintain, and work any railways, tramways, lines of telegraph, telephones, or other means of transport or communication in Chili and Bolivia, and for the above purposes to enter into and carry into effect such concessions or authorities as may be deemed necessary or desirable, and to undertake and perform the obligations of any concession. The first subscribers are:

	Shares.
M. Concha, Toro, Santiago, Chili	1
E. M. Underdown, The Temple, E.C.....	1
S. H. Griffin, K.C.S.I., 9, St. James's-street, S.W.	1
R. H. Glyn, 88, London-wall, W.C.	1
W. May, Caversham, near Reading	1
C. W. Forde, 252, Cornwall-road, W..	1
W. A. Pillman, 7, St. Stephen's-gardens, W.	1

The number of Directors shall not be less than three nor more than six, and the first shall be appointed by the subscribers to the memorandum of association. The qualification of a Director shall be the holding in his own right of at least £500 in the capital of the Company. The remuneration of the Directors shall be £2,000 per annum.

CITY NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts of this Company amounted to £4,672.

West Coast of America Telegraph Company.—The receipts of this Company for the month of November amounted to £5,975.

Eastern Extension Telegraph Company.—The traffic receipts for the month of November were £45,234, as against £39,000 for the same period of 1887.

Mining and General Electric Lamp Company, Limited.—Letters of allotment in the Mining and General Electric Lamp Company, Limited, have been posted.

Great Northern Telegraph Company.—The receipts for November were £24,000, making a total from January 1 of £250,200, against £242,880 and £239,000 for the corresponding periods of 1887 and 1886 respectively.

West India and Panama Telegraph Company.—The estimated receipts of this Company for the half-month ended November 30 were £2,889, as compared with £2,689. The August receipts, estimated at £5,002, realised £5,149.

Telegraph Construction and Maintenance Company, Limited. This Company notify that they are prepared to renew the £150,000 six per cent. debentures falling due January 1 next, for a further term of five years, at 5 per cent. interest.

Brazilian Submarine Telegraph Company.—A quarterly interim dividend of 3s. per share has been declared by the Directors of the Brazilian Submarine Telegraph Company, Limited, payable December 24. The traffic receipts of this Company for the past week amounted to £5,600.

Cuba Submarine Telegraph Company. — The number of messages passing over this Company's lines during November was 4,013, estimated to produce £3,100, against 3,343 messages, producing £2,998 in the corresponding month of last year. The traffic receipts for August, estimated at £2,800, realised £2,860.

Companies of the Month.—The following electrical companies have been registered during the past month:

Antofogasta (Chili) and Bolivia Railway Company, £100 shares	£1,450,000
Douglas Patent Clock and Electric Meter Company, £10 shares.....	10,000
Humboldt Electric Power and Mining Company, £1 shares	82,500
Lancashire Electric and Engineering Company, £5 shares	20,000
Manlove, Alliott and Company, £10 shares	100,000
Mining and General Electric Lamp Company, £1 shares ...	100,000
Sungei Yung (Malay Peninsula) Railway Company, £10 shares	75,000
Windsor and Eton Electric Light Company, £5 and £1 shares	30,000

PROVISIONAL PATENTS, 1888.

NOVEMBER 23.

17,063. **A new or improved electric spray-producing apparatus.** Hilarion Antoine Bernard Huguet (de Vars), 1, Castle-street, Holborn, London. (Complete specification.)

NOVEMBER 24.

17,123. **Improvements in apparatus for electrically regulating or synchronizing clocks.** Carl Albert Mayrhofer, 46, Lincoln's-inn-fields, London, W.C. (Complete specification.)

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17,127. **Improvements relating to the conveying of electrically-charged wires.** David Yewdall Cliff, 8, Quality-court, London.

NOVEMBER 26.

17,155. **Improvements in electrical spring switches.** Edward William Lancaster, Albert Works, Graham-street, Birmingham.

17,163. **Improvements in electrical switches and other electrical instruments.** Frederick Lawrence Rawson and William White, 11, Queen Victoria-street, London, E.C.

NOVEMBER 27.

17,222. **Improvements in electric lamps or lighting apparatus.** Leonard Paget, 45, Southampton-buildings, London. (Complete specification.)

17,223. **Improvements relating to electric secondary batteries or accumulators and to the manufacture of electrodes therefor.** Leonard Paget, 45, Southampton-buildings, London. (Complete specification.)

17,224. **Improvements in and relating to electrical apparatus for propelling tramway and other vehicles.** Leonard Paget, 45, Southampton-buildings, London. (Complete specification.)

17,225. **Improvements relating to the generation of electricity and the simultaneous production of zinc chloride and other bye-products.** Leonard Paget, 45, Southampton-buildings, London. (Complete specification.)

17,238. **Improvements in or relating to dry piles for electrical purposes.** George Cecil Dymond, 6, Lord-street, Liverpool. (Louis Moorthamers, Belgium.)

17,249. **An improvement in electric meters.** Francis Teague, Crown-yard, Stanhope-street, N.W.

NOVEMBER 28.

17,276. **Improvements in and relating to portable galvanic batteries.** William Joseph Starkey Barber-Starkey, 70, Market-street, Manchester.

17,289. **Improvements in gearing for electric tramcars, etc.** Herbert Wood Houlden, Sprotboro', Doncaster.

17,325. **An improved combined electrical bell, battery, and push, for street-door and other purposes.** Alfred William Armstrong, 132, Southwark-street, London, S.E.

17,326. **The adaptation of electricity or clockwork in conjunction with either lenses, reflectors, or an aphengescope, or combined to transmit different advertisements automatically without manual power.** Alfred William Armstrong, 132, Southwark-street, London, S.E.

17,340. **Improvements in electro depositing cells.** Philip Middleton Justice, 55 and 56, Chancery-lane, Middlesex. (Edward L. Smith, United States.) (Complete specification.)

NOVEMBER 29.

17,353. **Combination automatic commutating and electric fire and police alarm and public alarm.** George Durham, 5, Beauchamp-street, Shaw Heath, Stockport.

17,394. **Improvements in electric lampholders.** Gustav Binswanger and Hugo Hirst, 5, Gt. St. Thomas Apostle, E.C.

17,420. **Improvements in the method of and in machinery for the manufacture of metallic pipes and rods, and for covering the same, and telegraph and telephone cables and wires, with lead or metallic compounds for electric purposes.** Alexander Wylie, 8, Quality-court, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

DECEMBER 24, 1887.

17,726. **Improvements in or connected with electro-motors.** John Grice Statter, Norfolk House, Norfolk-street, London, W.C.

JANUARY 26, 1888.

1213. **Improvements in the application of electricity to spectacle frames.** John Taylor Leighton, Gray's-inn-chambers, 20, High Holborn, London, W.C.

JANUARY 30, 1888.

1383. **Electric apparatus for use either as an electro-motor or as an electric current meter.** François Borel and Emile Paccaud, 68, Fleet-street, London, E.C.

JULY 31, 1888.

11,065. **Improvements in or relating to apparatus for supplying variable amounts of electricity to and thus regulating the brilliancy of electric lamps.** William Phillips Thompson, 6, Lord-street, Liverpool. (George Westinghouse, jun., United States.)

AUGUST 13, 1888.

11,681. **Improvements relating to electric batteries and to exciting liquids or compounds therefor.** Carl Eduard Liebert and Sally Adolf Rosenthal, 45, Southampton-buildings, London.

OCTOBER 25, 1888.

15,388. **Improvements in apparatus for regulating dynamo-electric machines.** Arthur Shippey, 321, High Holborn, W.C. (Addison G. Waterhouse, United States.)

OCTOBER 30, 1888.

15,612. **Improvements in insulators for electrical conductors.** John Charles Love, 321, High Holborn, London, W.C.

SPECIFICATIONS PUBLISHED.

1887.

3533. **Electric railway signalling apparatus.** A. M. Clark. (Gould.) (Reprints with alterations.) 8d.

14,494. **Electrolysing chlorides, &c.** W. Spilker. 8d.

16,537. **Application of electricity to propel vehicles.** F. Wynne. 1s. 1d.

16,962. **Stays for telegraph poles, masts, &c.** F. Rudall. 8d.

17,585. **Electric regulators.** N. Benardos. 6d.

17,846. **Telephonic apparatus.** G. L. Anders and others. 6d.

17,926. **Safety fuses for electrical circuits.** W. E. Hayne. 8d.

1888.

115. **Insulation of electric appliances.** S. W. Baynes. 4d.

569. **Recording and reproducing sounds and electric currents.** W. Hedick. 11d.

11,817. **Electric furnaces.** J. C. Hebbs. 6d.

11,890. **Etching, &c., by galvanic action.** C. R. Bonne. (Schaefer.) 4d.

13,584. **Electrical toll-tales.** E. Meyer. 6d.

13,984. **Electrical accumulators.** B. J. B. Mills. (Barbier.) 8d.

14,129. **Dynamo-electric machines.** H. H. Lake. (Thomson.) 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday	Dividend.		Name.	Paid.	Price. Wednesday.
2 July	4%	African Direct 4%	100	101	1 March	5%	Gt. Northern 5% Deb., '83.	100	106
12 Feb.	1/2	Anglo-American Brush E.L.	4	5	27 July	10/0	India Rubber, G. P. & Tel.	10	17½
12 Feb.	2/0	— fully paid	5	5¼	26 Oct.	12/6	Indo-European	25	40
26 Oct.	7/6	Anglo-American	100	47	14 Nov.	2/6	London Platino-Brazilian	10	8
26 Oct.	15/0	— Pref.	100	77½	16 Mar.	5%	Maxim Weston	1	⅛
12 Feb., 85	5/0	— Def.	100	15⅜	30 May	2½%	Oriental Telephone	11	½
14 Nov.	5/0	Brazilian Submarine	10	13¼	26 April	4/0	Reuter's	8	7½
14 Nov.	0/4½	Con Telephone & Main	1	1⅛	...	...	Swan United	8½	2⅝
10 Aug.	9/0	Cuba	10	14⅛	10 Aug.	13½%	Submarine	100	145
10 Aug.	10/0	— 10% Pref.	10	19	15 Oct.	6%	Submarine Cable Trust	100	97
12 Oct.	2/0	Direct Spanish	5	4½	12 July	12/0	Telegraph Construction	12	40½
12 Oct.	5/0	— 10% Pref.	5	10	2 July	6/0	— 6%, 1889	100	105
26 Oct.	2/0	Direct United States	20	9⅞	29 Nov.	5/0	United Telephone	5	13⅜
12 Oct.	2/6	Eastern	10	12⅜	27 July	3/0	West African	10	8
12 Oct.	3/0	— 6% Pref.	10	15	1 Sep.	5%	— 5% Debs.	100	99
1 Aug.	5%	— 5%, 1899	100	109	12 July	4/0	West Coast of America	10	9½
26 Oct.	4%	— 4% Deb. Stock	100	106	30 June	8%	— 8% Debs.	100	125
12 Oct.	2/6	Eastern Extension, Australasia & China	10	12⅜	26 Oct.	6/0	Western and Brazilian	15	13½
					26 Oct.	6/	— Preferred	7½	6½
1 Aug.	6%	— 6% Deb., 1891	100	106	11 May	2/1½	— Deferred	7½	6¾
2 July	5%	— 5% Deb., 1900	100	106	1 Aug.	6%	— 6% A	100	109
2 Nov.	5%	— — 1890	100	102	1 Aug.	6%	— 6% B	100	107
2 July	5%	Eastern & S. African, 1900	100	106	...	...	West India and Panama	10	2¼
28 Mar.	8/3	German Union	10	9½	29 Nov.	12/0	— 6% 1st Pref.	10	11⅜
12 Oct.	1/0	Globe Telegraph Trust	10	6⅞	13 May, '80	...	— 6% 2nd Pref.	10	12
12 Oct.	3/0	— 6% Pref.	10	14½	2 Nov.	7%	West Union of U.S.	$1,000	122
30 April	5/0	Great Northern	10	14⅜	1 Mar.	6%	— 6% Sterling	100	104

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NOTES.

Factory Burnt.—The noted Fort Wayne Jenney electric works was totally destroyed by fire on Nov. 23.

St. Olaves.—The St. Olave District Board has resolved to enter its objections to the proposals of the House-to-House Electric Light Company to provide the electric light in the district.

Chelsea.—At the meeting of the Chelsea Vestry held on December 4 permission was given to the Chelsea Electricity Supply Company to lay electric lines in the neighbourhood of the Pavilion-road.

Boyle.—The Town Commissioners of Boyle, Ireland, are contemplating the introduction of the electric light, and are in communication with the firm of Messrs. J. K. Fahie and Son, of Dublin, on the subject.

The Christmas Demand.—The Electrical Power Storage Company are working night and day to cope with the increased demand for storage batteries specially required to be delivered by Christmas.

Accident to Edison.—Mr. T. A. Edison had a narrow escape last week. He was thrown from his buggy while driving from his laboratory; his coachman was badly injured, and the horse had to be shot.

Electric Power in a Hat Factory.—A factory for the manufacture of straw hats, in Providence, U.S., previously driven by a steam-engine, is now entirely supplied by power with a Thomson-Houston motor.

France.—The Continental Edison Company will shortly establish two new central stations in France—one at Grenoble, comprising 600 incandescent lamps on the Zipernowski transformer system; the other at Perigueux, for 800 lamps on the three-wire systen.

Electric Welding.—How is it we do not seem to hear much of the spread of electric welding in England? The process seems to be going ahead in America, and, we imagine, will eventually prove exceedingly useful and profitable to all sorts and conditions of large and small industries.

St. George-the-Martyr.—Two formal notices were received by the St. George-the-Martyr Vestry under the Electric Lighting Act, one from the House-to-House Electric Lighting Company, and the other from the London Electric Light Corporation. The matter was referred to the Roads Committee.

Rotherhithe.—The London Electric Supply ask for the Vestry's support to their application for a provisional order. At the last Vestry meeting, Mr. Down remarked that the parish wanted more light, that this was a move in the right direction, and the Vestry ought to write stating that they would offer no opposition. The matter was referred to committee.

Barnet.—The electric light at Barnet suddenly went out on Saturday night. The occurrence was the more unfortunate on account of the busy state of the streets on Saturday night. The cause of the mishap, we have ascertained, was that a projecting nail rubbed off the insulation of the wire and made contact to earth. The short circuit which ensued resulted in the melting of the main wire.

Mining Lamp Company.—The shares in the recently-organised Mining and General Electric Lamp Company, Limited, were allotted last week. Earl Crawford has written to say that he thinks it only right, as his name and the names of his friends, the Hon. Reginald Brougham and Mr. James G. Stephen, were on the prospectus, that the public should know that they had resigned their seats at the Board prior to the allotment.

Electric Light in Pearl Fishing.—The *Madras Mail* says that Dr. Thurston, the superintendent of the Madras Museum, has been requested by the Board of Revenue to visit various electrical establishments in Europe in order to select an electric globe light to shine in 20 fathoms of water. Such a light is wanted at the pearl fisheries, for, up to the present, the work of the fisheries has been confined to comparatively shallow banks.

Optic Cell.—M. Chaperon has recently exhibited a galvanic cell designed by himself, in conjunction with M. Mercadier, which is sensitive to light. The elements are one a plain silver plate, and the other silver covered with sulphate of silver, immersed in weak solution of nitric acid. The E.M.F. varies as the intensity of the light to which it is exposed, and M. Chaperon proposes to use this cell in photometry, and also in optic telegraphy.

Montreal.—A syndicate has been formed, consisting of the Edison Company, a firm of engineers, and several Montreal capitalists, to purchase the Isle of Heron, in the centre of the Lachine Rapids. It is proposed to light the city of Montreal with the water power, of which it is estimated there will be some 250,000 h.p. available. The company proposes tendering for the public lighting, as well as the supply of private houses and factories with light and power.

Reading.—The Town Council of Reading have agreed to permit Messrs. Laing, Wharton, and Down to fix some experimental electric lamps in the borough, and these will be inaugurated in a few weeks. Six 1,200 c.p. arc lamps will be erected, and run for a month free of charge, the situations being near the Queen's statue, at the corner of Valpy and Blagrave streets, near King's-road Corner, in the centre of the Market-place, opposite the Post Office, and near Cross-street, respectively.

Bradford.—At a recent meeting of the Town Council, Alderman F. Priestman, in moving the adoption of the proceedings of the Gas Supply Committee, explained that owing to a fire at the works of the contractor for the engines for the electricity works, by which the internal portions of the mechanism had been destroyed, the electric light would not be installed before the end of March. A number of persons had already signed agreements to take a supply of electricity for three years.

Another Telegraph Station Wanted. — Mr. J. D. B. Lewis, 20, Bucklersbury, writing last Friday to the daily press, gives voice to a public want. He says: "On arriving at Broad-street Station to-day I had to walk nearly a quarter of a mile through the rain to send a telegram. I suggest that in an important centre like Liverpool-street a telegraph station is a *sine quâ non* to business men, and I trust that you will lend your valuable aid to induce the Post Office to establish a station there."

Melbourne Award.—News has been received by special cablegram of the fact that Messrs. Ransomes, Sims, and Jefferies, Limited, Ipswich, have just been awarded a gold medal for their steam-engines at the Melbourne Centennial Exhibition. The exhibit for which the gold medal was awarded comprised 14 h.p. double cylinder portable engine, 8 h.p. single cylinder portable engine, 12 h.p. long-

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stroke engine with automatic expansion gear, 6 h.p. short-stroke engine, 4 h.p. vertical engine, and 10 h.p. compound semi-fixed engine.

Pulsation.—We are informed that the electric light in use at the classrooms at the Polytechnic, Regent-street, pulsates very much, and is trying to the eyes of students. The benefits of the electric light in coolness and steadiness are discounted considerably when a regular rise and fall in brilliancy is always occurring. We should suggest that the electrician in charge should draw the attention of the authorities to the desirability of the addition of a heavy flywheel, or a set of accumulators: these latter, by the bye, would enable more light to be supplied with the same plant.

Telephone to the Stock Exchange. — It is announced as a piece of news that the Stock Exchange is to be connected by telephone at the beginning of the year by the Exchange Telegraph Company; the system is to be open to members only. It seems rather late in the day for a telephone system to be inaugurated at the place which it would have been imagined would be the first to adopt it. The question, it seems, has been before the Stock Exchange Committee for years, and the members must greatly welcome the addition, at last, of such a facility to business.

Reckenzaun's Tram System. — We understand that the Central Street Railway of Sacramento, California, has just adopted Mr. Reckenzaun's system of electric traction with entire success. It may be remembered that some time since we called attention to the goaheadness of America in this direction, and the seeming lack of enterprise in England. Since then a good deal of progress has been made here, and if the reports which continually come to hand are fulfilled in the letter, next year will see electric traction fairly started in various directions upon a fairly practical scale.

Study of Marine Organisms.—A paper on the advantages of the use of the electric light in the observations of marine zoology is published in the *Comptes Rendus* by M. de Lacaze-Duthiers. An account is given of the system of electric light now in use at the Arago laboratory of the Banyuls station, by means of which the author has been enabled to carry out some of the most important recent observations on marine life. The transparent animals especially can be studied with advantage in a luminous atmosphere, revealing even the embryonic organisms, which cannot be detected in ordinary light.

The Use of Candles in Photometry.—At last Friday's meeting of the Metropolitan Board of Works, the clerk reported the receipt of a letter from the South Metropolitan Gas Company, expressing their opinion that the parliamentary standard candle used for testing gas is of a very uncertain and unreliable character, and that it is desirable to obtain parliamentary sanction for the adoption of a new and reliable standard, and asking the Board to receive a deputation from the company on the subject. We should imagine that in this request the gas companies will be cordially supported by the electric light companies.

Sunderland.—The offer of the Northern District Telephone Company to connect the various departments of the Sunderland Corporation with each other and the Telephone Exchange for £100 per annum, has been accepted. This amount is only £20 more than they are paying at present, and they will get greatly increased facilities. At present the wires connected with the hospital, medical officer's house, etc., are all private wires, but in future they will be put on the exchange, and thus any medical man or other gentleman could communicate with their medical officer or hospital. There will also be improved facilities for communicating with other departments.

Winchcombe.—While Cheltenham is dallying with the question of electric lighting, and has practically even dropped the matter for the present, the neighbouring little town of Winchcombe has taken the matter up with vigour. After a lecture the other night, in which the lecturer went fully into the question of actual cost for lighting with electric light, strong feeling was expressed that the matter ought to have a practical outcome; a meeting had been convened to listen to the lecture, and as a result was almost unanimous upon the desirability of introducing the light at once into Winchcombe. It was thought possible to utilise a certain amount of spare water-power for this purpose.

American Storage Batteries.—We learn that the Woodward Electrical Company, of Detroit, have arranged to supply the Detroit battery to the English market. Messrs. Shippey Brothers, Limited, have been appointed sole agents for the United Kingdom pending the establishment of works in England to manufacture the Woodward plate for European markets. The patents of the Woodward battery, which is of the Planté spongy lead type, are held by a powerful group of American capitalists, who have recently extended the works to turn out 500 cells per day. Messrs. Shippey Brothers will shortly have on view a complete range of batteries in all sizes for lighting, traction, and medical purposes.

Cowpen.—It was definitely stated last week in the Blyth newspaper, which has all along argued so strenuously against the introduction of electric light by the Local Board at Cowpen, that the scheme was actually abandoned, only two members (the promoters) voting for it at the final discussion. This, it appears, was very far from representing the state of the case. Further meetings have been held, and the tender of Messrs. Nicholson and Jennings for lighting the town with arc lamps for the sum of £550 for a term of five years, with option of purchase by the Board at the end of this period, has been initialled by the chairman for acceptance. We have received the following telegram from the Local Board at Cowpen: "Tender accepted, subject to terms; contract arranging."

Ipswich.—Central station work at Ipswich, we are informed, was quietly inaugurated last week. Premises in Carr-street have been taken by Messrs. Laurence, Paris, and Scott, Limited, and in the backyard of what will be a new central station, a portable engine by Messrs. Ransomes, drives a dynamo, from which current is conveyed. The office of the *East Anglian Times*, who have hitherto produced their own electricity from engines supplying the power for printing, are among the first customers, and the supply proved perfectly successful. The engine power at the lighting station in Carr-street will, it is expected, soon prove inadequate for the anticipated consumers of the light, by which time a cable will be laid to the Orwell Works; and with the engine power at that establishment all Ipswich might readily be lighted.

Dublin.—At a meeting of the Dublin Corporation on the 5th inst. there was a sharp discussion anent a sum of £2,300 estimated for the purpose of carrying out a scheme of electric lighting for the city. It will be remem-

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bered the Corporation have already obtained a license, and are now seeking a provisional order—firstly, to place themselves in the strongest possible legal position as regards electric lighting, and, secondly, in order to checkmate the gas company, who are also promoting a provisional order under the Act of 1883. After a protracted discussion, an amendment was carried by 17 to 16 votes reducing the amount asked for by £1,300. Seeing the narrowness of the division and the smallness of the number voting—33 in a body consisting of 60 members—it is feared that the principle of introducing the electric light at present will be brought up for further consideration at an early date.

Telegraphy to the Continent.—In the House of Commons, on Monday, Sir G. Campbell asked the Postmaster-General if he could give any further information as to the new arrangements for telegraphy to the Continent, and the rates to be charged; whether it was true that it was proposed still to charge 2d. per word to France and Belgium, of which at least 1d. was for cable transit across the Channel; and whether, at the modern cost of manufacture, a paying cable could be laid across the Channel at a less rate than 1d. per word. Mr. Raikes said: When the Post Office undertakes the working of the cables to the Continent the charge per word to Belgium will not at first be altered, but the charge to France, which is now 2½d., will be reduced to 2d. No particular proportion of the charge has been assigned to the cable transit. I am not in a position to give any information as the acquisition of the plant of the Submarine Telegraph Company, as no agreement on the subject has been arrived at. No pains will be spared by the department to ascertain the necessary cost of services such as this.

Julien Cars.—Three accumulator cars are now run by the Julien Company on Fourth and Madison avenues, New York. Until recently the cells were charged every trip of 12 miles. Now they are only charged at the second trip—24 miles; and it is hoped soon to run the whole day's work of three round trips—36 miles—with one charge. The company has done a great deal of experimental work on the three cars now in use, and has put them to such practical tests as to be able to settle on a standard. Hereafter, the standard car of the Julien Electric Traction Company will be an 18ft. body, mounted on an independent rigid truck, with a 6ft. wheel base and (on the Fourth-avenue line) a 15 h.p. motor geared to each axle. The car will carry 144 cells in six groups of 24 each. This novel grouping is for economy; for by this means the motors will be run most of the time in series, instead of together in parallel, as at present. It is a remarkable fact that none of the Julien cars have yet broken down or become disabled since they were put in service, but have always got back to the station without any external aid.

St. Martin-in-the-Fields.—At the meeting of the Vestry on November 29 the Parliamentary Committee reported that they had considered a letter (November 19) from Messrs. Deacon, Gibson, and Medcalf, on behalf of the London Electric Supply Corporation, stating that generally their clients are prepared to accept a license upon the lines laid down in the South Metropolitan Electric Supply Company's Provisional Order (Mins., October 18, par. 7), but there are some points in which that order would be inapplicable to them and to their system, and requesting that they and one of their directors may attend the committee for the purpose of affording explanations, and the Right Hon. the Earl of Crawford and Balcarres and Mr. Medcalf attended accordingly, and called attention to the alterations, additions, and amendments they desired to be made in the provisional order above referred to; and the committee recommended that the clerk be instructed to confer with the solicitors to the company for the purpose of further considering the proposed alterations, and reporting thereon to the next meeting of the committee. Resolved, that the report of the committee be approved, their proceedings as reported be approved, and their recommendation be adopted and acted upon.

Telegrams for Lifeboats.—In the House of Commons on Monday, Mr. Bond asked the First Lord of the Admiralty whether the Admiralty telegraph wire connecting St. Aldhelm's Head with the post office at Corfe Castle would be available for summoning lifeboat or other assistance in case of wreck or apprehended wreck; and, if so, whether arrangements could be made for keeping open the post office connection during stormy nights, thus obtaining its assistance in summoning either the Swanage or Kimeridge lifeboats during the whole night, as well as keeping up communication with Poole and Weymouth two hours later than under present arrangements. Lord G. Hamilton, in reply, said the Admiralty were anxious to do all in their power to assist the hon. member in his praiseworthy efforts to diminish the loss of life from shipwreck, and readily gave permission for the use of their telegraph wire between St. Adlhelm's Head and Corfe Castle for this purpose; but they had not the complete management of this telegraphic communication in their own hands. He was, however, informed by the Postmaster-General that arrangements could be made for keeping open the necessary connection at Corfe Castle, provided that the small expenses involved were defrayed by the lifeboat institution. If that proposal met the views of the institution, the Admiralty would give directions for the coastguard to co-operate, as far as was compatible with the performance of their own duties, in any arrangement that may be proposed for carrying out that good object.

Lecture on Domestic Electric Lighting.—On November 26th Mr. E. Thornton, of Barrow, delivered a lecture in the Institute at Grange on the above subject. The lecturer treated of various lights in use over the world, showing their disadvantages, etc. Coal gas, its merits and otherwise, was next considered. The unhealthy products from burning coal gas were dealt upon for some time. Mr. Thornton mentioned the amount of poisonous gas that was always produced when coal gas was being burnt, also moisture and other impurities that do so much to destroy decorations. The dangers of fire from gas were not forgotten, and numerous instances quoted. After mentioning so many disadvantages from the use of all lights other than electric, the lecturer next laid down the conditions necessary for a perfect domestic light, amongst which were: it must not be unhealthy, neither give off obnoxious fumes or absorb any oxygen, must be safe both life and property, no danger from fire, must be easy to manage, a pleasant light, and compare in cost with other lights. The electric light was now tested by experiment, and found to fulfil the conditions laid down. The manufacture of an incandescent electric lamp was experimentally demonstrated, and then lighted. The experiments included the effect of the electric current on various bodies and gases; incandescent lamps shown brilliantly lighted under water, to show that water, wind, and rain could not alter its light; a lamp was lighted in the lecturer's hand,

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proving there was no danger from fire; touching of uncovered wires, to prove no danger to the system; the induced currents, fusing of metals, etc. The current for the night was taken from a chemical battery, and also a small dynamo. During the evening three electric lamps were burning continually, other two at intervals. There was a good attendance, and the lecture was listened to with great interest, the experiment being very pleasing. Questions on any part of the subject of lighting by electricity were invited, and those who availed themseves of the offer were well satisfied with the answers. Votes of thanks brought the meeting to a close. Mr. Thornton's apparatus was then open to examination, and he explained the working of the various electric appliances on view.

Electric Light on Pullman Cars.—Electricity is gradually being adopted for train lighting, and in the new Pullman cars is an equal necessity with other luxurious fittings. A new Pullman vestibule train, which has been specially constructed for the London, Brighton, and South Coast Railway Company for their traffic between Victoria and Brighton, and fitted in the most luxurious style, ran its trial trip on Monday. This train will now run regularly between Victoria and Brighton, leaving Victoria at 10 a.m. and 3.50 p.m., and returning from Brighton at 1.20 and 4.45 p.m., and leaving Victoria again at 10.45 a.m., and returning from Brighton at 8.40 p.m. on Sundays. The train consists of three cars—named respectively "Princess," "Prince," and "Albert Victor," each of them being 58ft. in length. It is continuous throughout, enabling passengers to walk from end to end without any exposure. The "Princess" is the parlour car, devoted solely to the use of ladies, and is provided with a boudoir and dressing-room. The "Prince" is the buffet car, where light refreshments may be obtained, and the "Albert Victor," which is the smoking car, has capacity for seating 40 passengers. The cars themselves are built on the latest lines, and in the style adopted by the Chicago and New York limited expresses, and are lighted throughout with electricity. The power is generated by a dynamo connected with the axle of the train, and a sufficient number of accumulators is provided to light during stoppages. It may be interesting to add that, besides the conveniences provided for passengers in the way of lavatories and writing-tables, a small library, consisting of historical and other works, will be provided and placed at their disposal. The platforms which connect the cars are arranged with vestibules, which is done by enclosing the platforms all round with elastic and steel frames, forming a continuous buffer. These frames, when the cars are coupled, join closely together, and are kept in their place by springs forcing them tightly together, making the cars, as it were, into one, and affording great steadiness when running, thus affording security against telescoping in the case of accident. The new train has been constructed for the company by the Pullman Palace Car Company at the railway company's carriage manufactory in Brighton, under the supervision of Mr. John Miller, the secretary of the Pullman Company in Europe. Among those who took part in the trip were Mr. Allen Sarle, the general manager, and Mr. Charles Allport.

Machinery at the Cattle Show.—The Smithfield Cattle Show, which opened last Monday at the Royal Agricultural Hall, contained, as usual, a large number of engines and machinery for other purposes than agricultural ones. Messrs. Davey, Paxman and Co. have a fine show of engines and boilers of their well-known make. They show a 8 h.p. compound portable engine, of the same type as that which won the prize at Newcastle; a 6 h.p. horizontal; a 3 h.p. vertical engine; and also a 8 h.p. Essex vertical boiler. Messrs. Hornsby and Sons, Limited, exhibit a number of their usual type of fixed and portable steam-engines. Messrs. Robey and Co.'s principal exhibit at this show is a horizontal steam-engine of 10 h.p. nominal fitted with patent trip expansion gear. This engine is of substantial construction, suitable for doing heavy work, and is at the same time provided with a high-class expansion gear for securing the greatest economy of fuel and perfect governing under varying loads. It is an engine which, on an estate, can be employed for driving a dynamo, and in the daytime can be set to do thrashing, sawing, and other work. It is fitted with their patent electric regulator, and arrangements are made to show the action of this regulator upon the valve gear during the show. This regulator has a pair of electric solenoids, which attract and lift up an arm, altering the time of cut-off. By means of this regulator, the engine adapts its speed to the number of lamps burning, from full number down to a single lamp, and can also adapt itself to the work of charging accumulators. In addition, an 8 h.p. horizontal engine is exhibited, with link expansion gear and patent governor. This is of somewhat similar construction to the 10 h.p., still giving very excellent results, both as regards economy and regularity. It is not, however, so well adapted for being controlled by electricity. They also exhibit a 6 h.p. vertical engine fitted with automatic expansion gear of the same class, and one of their standard 8 h.p. portable engines. Messrs. Ransomes, Sims and Jefferies, Ipswich, exhibit their "Short Stroke" engine, specially designed for electric lighting, where a high speed on a heavy load is requisite. Messrs. Ransomes, Sims and Jefferies exhibit other engines of the usual type—agricultural, locomotive, undertype, vertical, etc. They also exhibit, for the first time, a "Long Stroke" engine, designed for slow speed, working the steam expansively. Messrs. Marshall, Sons, and Co., Limited, have a number of their splendid engines, portable and horizontal. Messrs. Ruston, Proctor, and Co. also show a fine display of engines and machinery. Messrs. Farmer, Robey, Clarke, and Co., of Gainsborough, and Messrs. Barrows and Co., of Banbury, also exhibit engines. Mr. E. S. Hindley, Bourton, Dorset, has several useful types of vertical engines; and a neat little compound vertical engine is exhibited by Messrs. Wallis and Steevens, Basingstoke. The Shipman oil fuel-engine is to be seen at the Cattle Show. This engine, looking, at first glance, something like a gigantic magic lantern, is exhibited as for electric lighting where small powers are required. It was just exhibited at the American Exhibition, and its use for electric light is spreading, particularly in Belgium, where there have been as many as 150 sold during last year. Mr. Van Rysselberghe, of telephone fame, has taken it up very warmly for lighting and testing purposes. The Shipman oil-engine exhibited 4 h.p., and stands about 5ft. high. The sole agents of the company are Messrs. John G. Rollins and Co., Limited Old Swan Wharf, London Bridge.

Electric Lamps from Cabbage Leaves.—In the *East Anglian Times* of December 7, in their fullest displayed type, is the following beautiful description of "A New Industry for Chelmsford," an industry which, if all went well, might revolutionise trade in that district, so that "cabbage" might do for Chelmsford in the future what cotton has done

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for Manchester in the past: "Electric Light from Cabbage Leaves.—Mr. Vandeleur, of Moulsham, writes: I think your readers may possibly be interested to hear something about the new process for making incandescent or 'glow lamps' for electric lighting, which has been worked out by Messrs. Swinburne, and which, if commercially successful, will be an entirely new industry for Chelmsford. Briefly, the process is as follows, certain essential details, however, which the inventors prefer to keep secret for the present, being of course, omitted. The essential novelty of the process consists in employing vegetable fibre for the 'filament' or thread. Almost any plant leaf will do, but after experiment it has been found that the leaf of the common cabbage answers the purpose best, as it is tough, and fairly homogeneous in structure. Each leaf is first separately examined by polarised light to detect any flaws or holes, the smallest pinhole rendering the leaf practically useless. It is then soaked in vinegar for 24 hours in order to neutralise the alkali in the fibre, and after thorough washing is ready for the next process. It is now laid out flat in a solution of mercury bromide; a rod of specially prepared shellac is then taken, and after being raised to a high potential condition by treatment with a silk exciter, it is put into contact with the mercury solution. By this means the leaf is gradually electrolised, the potassium and sodium in the fibre combining with the mercury to form a coating of amalgam. In this state the leaf is a capital conductor, and the inventors have even succeeded in using it as a substitute for lead in secondary batteries. A heavy current is now passed through it so as to carbonise the vegetable fibre, the current being increased till every trace of amalgam is volatilised. It is then cut into filaments, and each is forced through a draw-plate of polished chlorine. As it is not of sufficient 'resistance,' resort has to be had to a process called 'flashing.' This consists of passing a mixture of neumonia and hydrogen gases over it while is it heated by the electric current. The scaly brown incrustation of carbon monoxide is reduced by the pluroneumonic acid formed (the exact reaction is not known, but is something of this kind: $N H_3 + O C_2 + J = J O_2 + H_3$). The resistance rapidly rises, and at the proper point the current is automatically cut off by an ingenious switch arrangement. The filament is now bent into horseshoe form, and is ready to seal into the bulb. Perhaps the most important discovery made by Messrs. Swinburne is the enormous increase in light that can be obtained for a given current by employing an atmosphere of slightly compressed oxygen in place of the complete vacuum hitherto customary; and though by this means the life of the lamp may be slightly shortened, it is not considered important in view of the great gain in light. If this process, beautifully simple as a laboratory experiment, should prove commercially successful, large quantities of picked and selected leaf will be required, and Messrs. Swinburne contemplate inviting tenders from some of the leading growers in the county. The bulk of the plant has already been erected, and Messrs. Crompton and Co., of Chelmsford, who are working overtime, have got the machinery well in hand, and hope to complete delivery by the 24th inst." Is not the above as funny as the samples by our American friends?

The Daft Motor on the Elevated Railway.—While the question of drawing the City trains on the Underground has been exercising London engineers, the similar problem on the Elevated Railway of New York has, it seems, according to an account in the *Electrical World*, been successfully tackled by the Daft Electric Motor Company. It will be remembered that a Daft motor, which was named the "Ben Franklin," was tried upon the railroad, but did not prove signally successful; and the motor has been remodelled, and though differing very little from its original appearance, it returns with double the tractive power. The original motor had not been built of equal power with the steam locomotives in use, and, while handling two cars with sufficient facility, showed indications of overload in the effort of acceleration at starting its train. It was therefore decided to withdraw and reconstruct it with a capability equal in all respects to that of the steam locomotives. This work, often interrupted by more pressing claims for apparatus, has consumed the interval between the two appearances. While, as stated above, the present "Franklin" has double the power of the earlier, the only external difference is the addition of disc-cranks and connecting-rods, in order to avail of the adhesion to the rails of four wheels instead of two, and the substitution of brushes for the contact-wheel, in conveying the current from the conductor to the motive machinery. The difference in the contact arrangement is principally due to the changing of the conductor from an insulated track rail, centrally placed between the two others, to a §in. copper rod sustained by insulating brackets, secured to the guard-timbers alongside the track. This step was prompted by a desire for a better conductive system than the somewhat primitive makeshift of a third rail, which was also the cause of some inconvenience to the steam locomotives; and to make it without interruption to regular traffic occupied a long time, but was eventually accomplished without accident. The conductor extends from Fourteenth to Fiftieth streets, and measures, on both tracks and sidings, considerably over four miles. The rails, and, in fact, the entire elevated structure, constitute the return circuit. The power station, situated in Fifteenth-street, about 300 yards from the track, is equipped with a steam-engine of 250 h.p. and four 50 h.p. dynamos, whose current is led by heavy insulated wires, suspended from telegraph-poles, to the copper conductor on the railway structure. The present trial of the "Franklin" has covered about three weeks, and has been unattended by the slightest casualty or obstacle of any kind. The motor has more than realised the expectation of its designer, and some of its performances were as follows: The load was increased car by car until eight were in train, aggregating, with the motor, 122 tons; and these it started, ran and stopped easily, promptly, and with every indication of being well within its ultimate capacity. Finally, it ascended the maximum gradient in the route, 98ft. per mile, with the eight in tow, at a speed of seven and one-half miles per hour. The greatest load it was guaranteed to pull was four cars, which, with their seated load of 176 passengers and the motor, amount to 77 tons. With four empty cars, making a train of 66 tons, it has maintained a speed of 25 miles per hour up and down the track for a long period; and with three cars in tow, or 52 tons in train, it has maintained for a similar time a speed of 30 miles per hour. The outcome of such a notable achievement as the foregoing ought not to be difficult of divination. In the opinion of the Daft Company it cannot fail to be revolutionary when its full import is appreciated; for they claim that it implies maintaining the existing service on the New York elevated railways at barely more than half the present cost.

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PARIS INTERNATIONAL CONGRESS OF ELECTRICIANS.

The Commission of the International Congress of Electricians, which is to take place during the Paris Exhibition of 1889, held a preliminary meeting on the 19th November last. This commission consists of a number of distinguished French scientists and engineers, appointed by the French Minister of Commerce; and at the recent meeting the questions of invitations, date of the congress, and a definite programme of the order of discussion were considered. A list of proposed members of the honorary committee, who will direct the work during the congress, has been drawn up, to consist of 25 French members and 75 members of other countries. This list will be published upon receipt of their acquiescence.

The date of the opening of the congress has not yet been definitely settled, and will be announced later; but it will, in any case, be at some date after August 15, 1889.

The meetings of the congress will be open to all electricians on payment of a subscription of 20 francs. Subscribers will have the privilege of submitting papers, and will receive printed reports of the proceedings.

The following is the programme drawn up and definitely adopted by the commission:

Section I.

Measurements.

Units of measurement.—Recent work on the unit of resistance.—Connection between the electromagnetic and the electrostatic units.—New names of the principal practical units used in industry.

Measuring instruments.—Resistances.—Alternate and continuous currents.—Electromotive force.—Capacities.—Coefficients of induction.

Practical realisation of standards for current and for electromotive force.

Electric and magnetic properties of metals.

Section II.

Dynamos: Motors: Distribution of Electricity: Transformers.

Recent progress in the theory and construction of dynamos.

Different methods of calculating the parts of a machine.

Electromagnetic induction: with iron core: without iron core.

Machines for lighting, for transmission of work (generators and motors), for electrolysis.—Efficiencies.

Machines for distribution.—Different methods of automatic regulation.—Mechanical and electrical processes.

Transmission of power.—Systems of mains.

Central stations. The possibility of constructing very powerful dynamos.—Advantages and disadvantages of the employment of numerous groups of generators of medium power, or restricted numbers of generators of high power.—On the advantages of electrical coupling, or of the independence of the different groups.

Transformers.—Continuous current and alternate current transformers; comparison of the two systems. Theory; improvements; calculations of installations; exact determination of efficiency.

Different methods of distribution; automatic regulation of the parts of a distributive system.

Generators and motors for alternate currents.—Comparison with continuous current machines.

Discussion relative to dynamos and apparatus used in continuous current distribution, as compared with alternate current distribution with transformers.

Section III.

Electro-Chemistry.

I. *Batteries and Accumulators.*

Theoretical limits and practical mean values of the principal types employed in industry.—Electromotive force, cost, power, capacity, life, etc.

II. *Electrolysis.*

Electromotive force necessary for the electrolysis of the usual compounds of iron.—Conditions corresponding to a good deposition of the usual metals: copper, silver, gold, nickel, platinum, etc.—Strength of current, composition of baths, temperatures, etc., according to the quality and rapidity of the deposition desired.

III. *Electro-Metallurgy.*

Principal processes of the working, separation, or refining of metals.

Processes of the working of metals and alloys by electric furnaces.

Section IV.

Lighting.

Respective qualities of arc and incandescent lighting.—Advantages and disadvantages of high candle-power incandescent lamps.—Means to be employed for placing arc lamps in series or in parallel, without intermediate resistance between the dynamos and the arc regulators.

Processes of manufacture of incandescent lamps having for their objects:

1. To decrease the expenditure of electrical energy necessary for a given candle-power.
2. To increase the life of the lamps.

The best methods of installation and maintenance of central electric stations.

Section V.

Telegraphy and Telephony.—Various apparatus.

I. *Telegraphy.*

Employment of dynamos.—Establishment, employment, and duration of underground lines.—Telegraph lightning arresters.—Apparatus for rapid transmission, working, method of use.—Multiplex apparatus.

II.—*Telephony.*

Establishment of lines. Wires: steel, bronze and hard copper wire, compared.—Insulators.—Joints.—Poles and carriers for bundles of wires.—Bindings of wires to insulators.—Employment of overhead or underground cables.

Means employed to overcome induction between two circuits.—Metallic circuits.

Switchboards, simple and multiple: Number of subscribers served by one operator; number of communications able to be made by one operator in an hour; time necessary to establish a communication.

Exchanges; internal regulations; subscribers' rules.

Supervision and maintenance of subscribers' circuits.—Microphones.—Batteries.—Employment of the same *line* for several circuits.

Statistics.—Legislation.—Development of Exchanges.—Rates: Automatic service.

Long-distance telephony.

III.—*Other Applications.*

Application of electricity to railways, to civil engineering, to military and naval uses, electric clocks, time regulation, etc.

Section VI.

Electro-Physiology.

Comparison of the effects obtained by the use of electro-medical apparatus.

Necessity for defining the currents used in medical operations, and their relation to ordinary electrical units.

Best means to be employed to determine the nature of the electrical phenomena which may be produced in animals.

Effect of continuous and alternate currents upon living bodies.—Electrolytic effects in the tissues.—Dangers of electric installations.—Conductibility of organic bodies, and especially of the human body.

THE WEST BROMPTON CENTRAL STATION.

The central station of the House-to-House Electric Supply Company at West Brompton will be a rather large affair, as central stations now go. We have thought that a description and plan of the work will be interesting to our readers at the present state of progress. We have not been able to secure a plan to scale of the installation, but we

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give a sketch plan, which will serve to give a general idea of the arrangements in progress and contemplated.

The piece of ground chosen is situated directly next to the West Brompton Station, and, though narrow, is of considerable area, extending as it does to a long distance back. The size of the ground is 50ft. wide by 450ft. in length. Part only of the space is to be roofed over, and of that only a portion will be occupied by engines at present, the remainder—the spare ground at the back some quarter or third of the total length—will be available for future extension. The Lowrie-Hall system, as we have already stated in mentioning this station, will be here applied in its entirety

A block of buildings fronting the road are practically completed. These contain the offices of the company, and the stores and repairing shops. One of these shops will contain on the ground floor a small 2 h.p. engine, and a one or two unit Elwell-Parker dynamo, which will be used to charge the small accumulators used for meters—an integral part of the Lowrie-Hall system. The further of these buildings is designed with strong pillars, to support a large water-tank above and serve as a large coal-store below.

The boiler-house is laid out to contain 12 boilers of 150 h.p. These are Babcock-Wilcox boilers, working at 150lb. pressure. They are to be disposed in two sets of six boilers each, with two chimney-shafts, marked C on the plan. Three of these boilers are down at present, and one of the chimney stacks is completed, and the scaffolding is being taken down. There are to be two feed water heaters, each capable of supplying six boilers; a second tank for six boilers will also be erected.

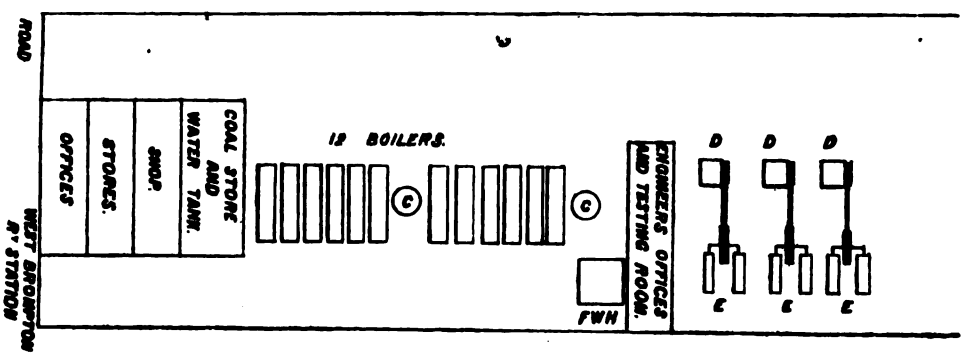
In the engine-house the foundations are laid throughout,

RECKENZAUN'S ELECTRIC TRAMCAR.

Messrs. Stephens, Smith, and Co., of Millwall, have just completed a new electric car to Mr. Reckenzaun's designs for the Sandhurst and Eaglehawk Tramway at Melbourne, and to the order of Messrs. Booth, Ellson, and Co., engineers and contractors, of the same city. On Wednesday we saw this car at 1, Cuba-street, Millwall. It embodies the results of the latest experience. The car body was built by Mr. George Milnes, of Birkenhead, and is made to take apart for shipment. There are two motors of 8 h.p. each, driving the two axles by means of the usual worm gearing, which is made to gear down in the ratio of 7 to 1. The motors are supported upon triangular frames, with three bearings threaded on the axles. Two of these bearings form part of a dust-tight cast-iron casing, within which the worm-wheel revolves, and lubricates itself by lifting up the oil from the bottom of the said casing. The third bearing rests upon the other axle. By supporting these frames upon three points, the wheels may run on uneven rails without throwing any extra strain upon the bearings. Between the motor and the worm-spindles, again, is a flexible coupling. Thus the centres can get out of line and yet allow the gear to work with freedom.

The current is furnished by 72 Reckenzaun's storage cells, which are placed under the seats on long trays in the usual manner. These trays run on rollers, and can be speedily drawn out through doors at the end of the car when they have to be replaced by a set of freshly-charged batteries.

The weight of the battery and connections and trays is nearly two tons, and the capacity of the cells 160 ampere hours.



Sketch Plan of the West Brompton Station.

and three engines, marked E on the plan, are partially fitted, two of them having their flywheels on. There are ultimately to be 12 of these engines, which are Fowler's double cylinder coupled engines, of 200 i.h.p., with flywheel on the centre. The flywheel is 14ft. diameter, weighing eight tons. Each engine is to work expansively, and is fitted with Hartnell's expansive gear. These will be connected by rope gearing, without counter-shafting, to the dynamos, marked D.

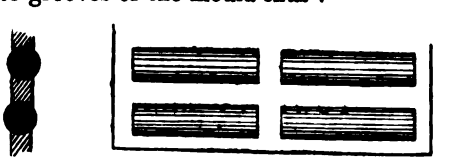
The dynamos are to be the new pattern Lowrie-Parker alternators, made by Elwell-Parker, Limited, of Wolverhampton, for the House-to-House Company; these we hope to be able to illustrate shortly. They are compact looking machines, with the rotating parts well covered in. The machines for this station are finished, and are awaiting the completion of the station.

A 10-ton travelling crane is arranged to run the whole length of the buildings for placing the engines and dynamos, etc., into position.

In the centre of the station, between the boiler and engine-house, is a building fitted with glass sides, so as to overlook the whole machinery. This contains the engineer's offices and switchboard-room. Rooms are also retained for the electrical testing-room, lamp stores, etc.

The people in the district are anxiously awaiting the starting of the public supply; some 20 or 30 houses have already been wired, representing about 2,000 lights, and many others are promised, and we should imagine the demand will be very general in the district. The local arrangements are in the hands of Mr. Chisholm, who is engineer-in-charge of the station.

The battery plates are made in a peculiar way. Numerous small cylinders of compressed litharge are placed, a short distance apart, into a cast-iron mould, and molten lead is poured in and holds the cylinders firmly. In order that the greater part of the cylinder is exposed, they are placed into grooves of the mould thus:



This gives a very strong plate; it can be bent and thrown violently on the floor without breaking the active material. Some of these plates have been working for three years, and are still in good condition.

The process of making these plates is not as simple as one would think from a short description, and a large expenditure in time and money has been made to arrive at a commercial system of producing them. A variety of shapes of active material have been tried, but cylinders of a certain size and a certain consistency have been found in practice best as regards durability and freedom from buckling.

The speed of the motor is regulated by a switch which, in turning, produces various combinations in the field-magnet coils of the motors, by throwing them all in series, or in parallel, or some intermediate positions, thus varying the resistances of the two motors. Each field-magnet has four equal coils—two on each leg.

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The car runs well, and has been tested on a grade of 1 in 20 with perfect success.

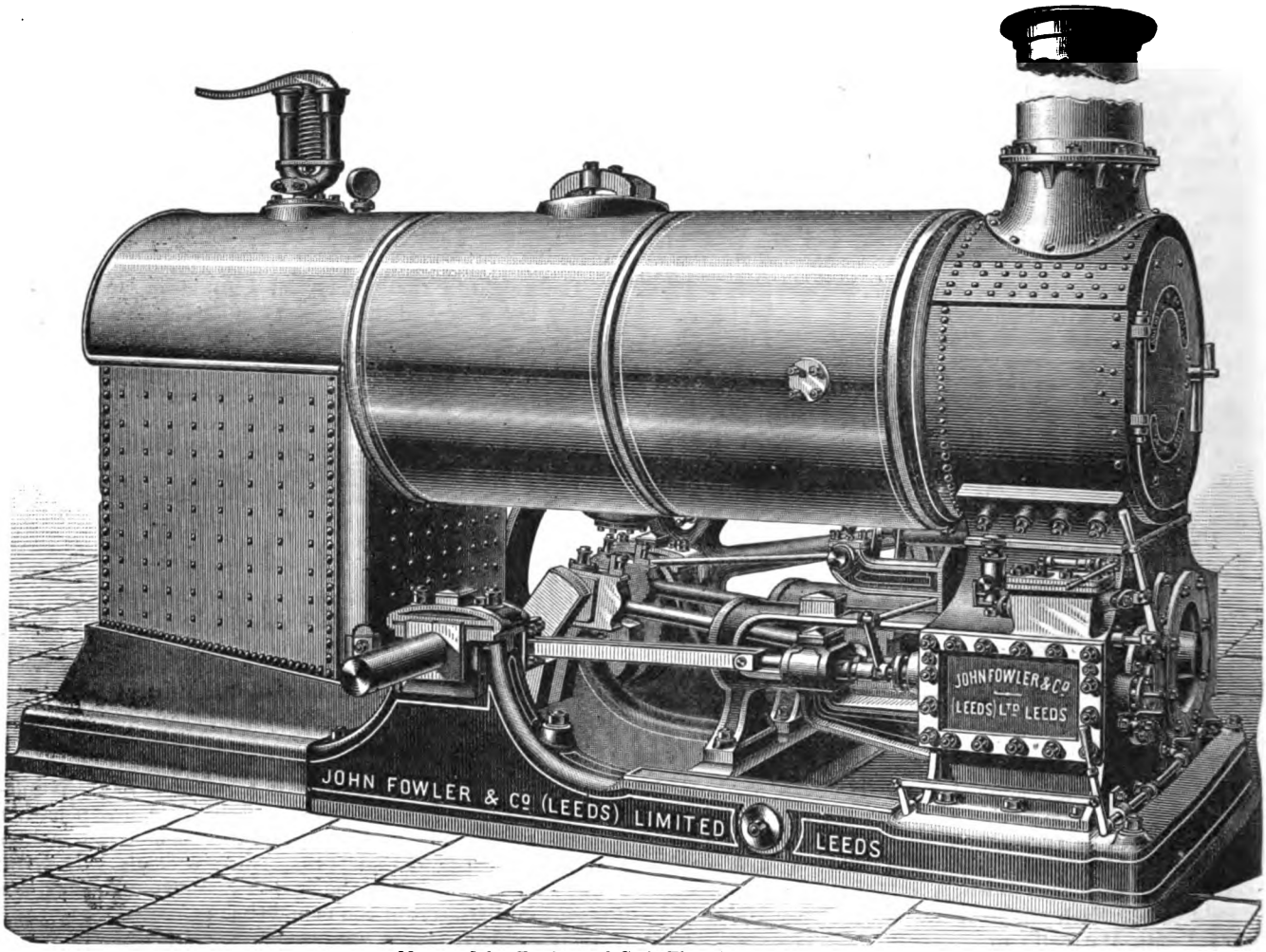
By the switch, which is a kind of vertical cylindrical commutator, and which is operated in the same way as the break-wheel on a locomotive, four different arrangements of the connections of the motors can be made thus:

(*a*) Four field-magnet coils of each motor in series.
  (i.) Motors in series.
  (ii.) Motors in parallel.

(*b*) Two legs of each field-magnet in parallel.
  (i.) Motors in series.
  (ii.) Motors in parallel.

In this way four different speeds can be obtained by turning the switch. A hand-break is employed tor stopping the car.

this type have been supplied to the Brighton Electric Light Supply Company which are developing 160 h.p., and consume in regular work only 1·9lb. of coal per indicated h.p. per hour. The cylinders are so proportioned that the work is divided equally between them, and the shocks to which an ordinary high-pressure engine is subject are avoided, and great steadiness in work is obtained. To facilitate starting, a suitable valve is provided for admitting steam from the boiler to the low-pressure steamchest, which is closed automatically; by this means more than the ordinary power of the engine is available if wanted for a short time. The engines are all fitted (except when fitted with link motion) with patent automatic expansion gear (Hartnell's patent, 1883), which ensures the greatest possible steadiness in running, and renders them specially suitable for electric light installations.



Messrs. John Fowler and Co.'s Electric Light Engine.

FOWLER'S ENGINES.

A short time ago we mentioned the application of the electric light to some new shops and warehouses at Birmingham, and stated that the power was driven from a Fowler engine. We herewith illustrate, by the courtesy of Messrs. Fowler, the type of their engine generally built for electric light purposes. It is a compound semi-fixed engine fitted with Hartnell's governor. Of these engines Messrs. Fowler attribute their economy in obtaining a great saving in fuel, and this is effected without complication and without increase in first cost. A high pressure of steam is maintained in the boiler (120lb. to 150lb.), and by the use of a high and low pressure cylinder it is expanded to about eight times its original volume, and is discharged at little above atmospheric pressure. The full elastic or expansive force of the steam is thus utilised, and a smaller quantity is used to develop the same power than in the old form of high-pressure engine, from which the steam is discharged in the atmosphere at a comparatively high pressure. Engines of

PHYSICAL SOCIETY.—Dec. 8.

Prof. REINOLD, F.R.S., President, in the chair.

Dr. A. Gamgee, F.R.S., and Mr. A. P. Trotter, B.A., were elected members.

The following communications were read: "*Note on a Modification of the Ordinary Method of Determining Electro-Magnetic Capacity*," by Mr. J. W. W. WAGHORNE, D.Sc. In determining capacity absolutely from the throw of a galvanometer, and a steady deflection through a known resistance produced by the same battery, error may arise from the imperfect elasticity of the fibre (when short), and the resistances required are often greater than can be conveniently obtained. The latter difficulty may be overcome by taking a known fraction of the potential difference used for charging the condensers to produce the steady deflection, and the former error may be reduced by observing the first swing due to the permanent current instead of the steady deflection produced by that current. By adopting this latter device the logarithmic decrement need not be determined, and the time required to make a measurement

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is considerably reduced. The formula for capacity (F) becomes $F = \frac{t d_1 b}{\pi G d_2 a}$, where t = periodic time in seconds, G = resistance of galvanometer circuit, d_1 and d_2 the throws due to the condenser charge and the permanent current respectively, and a and b the resistances in the battery circuit from the ends of which the potential differences used to produce d_1 and d_2 are taken. The above expression is not strictly accurate, because the damping effects on open and closed circuits are not identical; but in the cases observed by the author where the damping is not serious, the difference is negligible. A modified form of Pohl's rocking-key was shown, whereby the two throws, d_1 and d_2, could be rapidly observed, and readings could be taken in opposite directions to eliminate error due to torsion of the fibre.

Dr. THOMPSON pointed out that error frequently arises from the capacity of the key being appreciable where small condensers are being used; but the author stated that the modification was not intended for such cases.

Prof. AYRTON remembered having used, in conjunction with Prof. Perry, the throw due to the permanent current instead of the steady deflection when experimenting with condensers containing E.M.F.'s, and believed they abandoned it on account of the difference in decrement on closed and open circuits.

Mr. SUMPNER regarded galvanometers with small differences in damping, on closed and open circuits, as unsuitable for ballistic purposes, and mentioned the case in which the latter was only half the former.

Mr. BOYS considered the damping would be modified by having the condenser joined to the galvanometer terminals, and thought the decrement should be decidedly different from that on pure open circuit.

In thanking the author for his paper, the PRESIDENT said that any improved arrangements of well-known experiments or of lecture apparatus would always be gladly received; and reminded members there in bringing such before the society they would be carrying out one of the chief objects for which it was founded.

"*On Some Facts Connected with the Systems of Scientific Units of Measurement*," by Mr. T. H. BLAKESLEY, M.A. The author considers that the C.G.S. and practical (quadrant, volt, second) systems of units do not satisfy the requirements of a perfect system, in which the chief ends to be kept in view are: 1st, *Correlation;* 2nd, *Simplicity;* 3rd, *Comprehensiveness;* 4th, *Naturalness;* and 5th, *Convenience.* In a properly *Correlated system*, all the quantities considered should be so connected by the equations representing the laws of Nature, that no coefficients are required in expressing any unit in terms of others; for *Simplicity*, quantities essentially the same should be measured by the same unit; and to be *Comprehensive*, the system should embrace all the physical ideas which occur. To be *Natural*, its units should be closely or decimally connected with natural units, and for *Convenience* they should agree with established (though arbitrary) units, either actually or decimally. In the two systems referred to, correlation has been more completely realised than any of the others, but simplicity is by no means satisfactory, and the want of comprehensiveness was discussed by Prof. Rücker at the last meeting. The "second" is unnatural in not being a decimal subdivision of the solar day, and the gramme is derived from the centimetre by assuming the density of water to be unity, whilst the inconvenience arising from the relation between the horse-power and the watt or the erg is universally acknowledged. The general formulæ are given for converting magnitudes expressed in practical and C.G.S. electromagnetic measure into C.G.S. electrostatic units. Let k and h be the dimensions as regards length and mass when the quantities are expressed in the E.M. system, and n and q the corresponding numbers when expressed in the E.S. system, then 1 practical unit $= 3^{n-k}\, 10^{10n-11q+k}$ electrostatic C.G.S. units, and 1 C.G.S. electromagnetic unit $= 3^{n-k}\, 10^{10(n-k)+11(k-q)}$ electrostatic C.G.S. units, the 3 arising from "v" being taken as 3×10^{10} centimetres per second. Though the formulæ may be found useful, the author thinks it would be far better to adopt one system for all measurements, and suggests a "Coalition System," in which "v" is taken as the unit velocity. If in this system the "second" be retained, then the unit of length will be 30 earth-quadrants, and if the quadrant be taken (as in the present practical system) as the unit of length, then the unit of time will be $\frac{1}{30}$sec. The influence of such changes on present standards is then discussed, and the relation between the new unit of power and the horse-power (h.p.) found to be unsatisfactory. To endeavour to bring the h.p. and the unit of power into decimal relation, the author expresses the physical quantities in terms of length, time, and power, from a table of which it is evident what units will be affected by changing the unit of power, and tables of converting factors are given when the latter unit is taken as ·746 watt or as 7·46 watts. The correlation of temperature (θ) with other units is considered to be best effected by defining it so that J = 1 in the equation $m l^2 t^{-2} = J m c \theta$, "when the unit of temperature change would be that through which unit energy in the form of heat would raise a unit of matter possessing unit specific heat, and by choosing air at constant pressure as the standard substance, 1deg. C = 10^7 C.G.S. (air) units. A summary is given towards the end of the paper, in which the union of the two electrical systems, by choosing $\frac{1}{30}$ sec. as the unit of time, is recommended, the effect of which is to make the unit of capacity $\frac{1}{900}$ farad, and that of resistance 30 ohms. Before concluding, the author deprecates the practice of giving specific names to particular units, for by so doing subsequent necessary changes are made much more difficult.

Prof. RÜCKER expressed his opinion that temperature would be best correlated by expressing it as energy instead of making its dimensions $l^2 t^{-2}$, as suggested in the paper.

Dr. S. P. THOMPSON thanked the author for his prefix "*megisto*," denoting "multiply by 10^{12}." Referring to the choice of air as the standard for specific heat, he remarked that convenient coincidences were not always to be trusted, and that the specific heat of air depended on the pressure to which it was subjected.

Some improved polarising apparatus for microscopes were exhibited and described by Dr. S. P. THOMPSON. For polarising he uses an Ahrens prism, and for analyser a flat-ended one of his own design. The Ahrens prism is formed from a rectangular block of spar, two faces of which are perpendicular to the optic axis; two cuts parallel to the axis are made from the middle of one side to the ends of the opposite, and the cut faces are polished and cemented by Canada balsam. A short prism with wide angle is thus obtained, which can be readily fitted to the substage of the microscope. The analyser, which consists of two wedges of spar, is mounted in a tube which fits in the eyepiece, and by recognising that the upper end need not be larger than the pupil of the eye, the author has been able to considerably reduce the length of the prism, and still keep the bottom end large enough to collect all the rays passing through the eyepiece.

Several ingenious methods of cutting spar so as to produce prisms with minimum waste were described and illustrated by models, and a "Nicol," made by the inventor at the age of 79, was exhibited.

Mr. LANT CARPENTER asked the author why he condemned analysers placed directly behind the objective? for, in his experience, this arrangement gave the most satisfactory results.

In reply, Dr. THOMPSON said his experience was decidedly different from that of Mr. Lant Carpenter, and mentioned that Zeiss had abandoned the common arrangement, and now introduced his analyser between the two lenses of his Huyghenian eyepieces.

Non-Magnetic Balance.—Mr. E. Golay, says *The Horological Journal*, has patented a new non-magnetic balance. The invention consists in the combination of two alloys, which produces a non-magnetic and oxidisible compensating balance-wheel, which produces perfect regulation. The interior ring of the balance-wheel is formed of an alloy composed of about 40 per cent. platinum, 35 per cent. copper, and 25 per cent. nickel; the external ring is formed of an alloy consisting of about 55 per cent. silver, 35 per cent. zinc, and 10 per cent. copper.

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Vol. I., new series, of "THE ELECTRICAL ENGINEER" *(Vol. IX., old series) is now ready, and can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

POWER.

"Knowledge is power" says the old saw, but knowledge won't turn the machine, which requires energy of a more manageable kind. Was it Budge or was it Tod who wanted so badly to see the "wheelse go round"? If these precocious young rascals could pay a visit to Messrs. Immisch's and see the newly-invented printing machine of M. Lafitte at work, they would surely see enough wheels going round to last them a lifetime. It is not our intention to describe a printing machine, even if the principle upon which it is constructed is ever so new, but we do wish to call attention once more to the economies and conveniences electricity offers when its energy is utilised through the means of a motor in providing driving power for machines used in industrial operations. The fact is gradually dawning upon the minds of "electricians" that the distribution of energy has a great future before it. Some few have recognised the possibilities for years, and so long since as the Paris Electrical Exhibition in 1881, and again at the Crystal Palace Exhibition, we remember casually discussing the question with Major Flood Page. No doubt since then his attention has chiefly been directed to the development of another branch of electrical work rather than in the direction indicated. Dr. Hopkinson, if we mistake not, exhibited, through Messrs. Latimer, Clark, Muirhead, and Co., a motor at Paris in 1881 designed to work a hoist or lift, and since then "motors" have gradually been introduced into everyday work. In England, Messrs. Immisch and Co. have made this branch of electrical work a speciality; in America, probably Mr. Sprague has done more than anyone else to force public attention to the capabilities of electric traction and transmission of power. We intend in this article to speak more directly to users of small power rather than to electrical engineers, who may be regarded as sellers of power in contradistinction to the others, who are buyers. Prof. Ayrton at Sheffield, and again at Bath and at the London Institution, has lectured, or is to lecture, in favour of electrical transmission of power. As lectures go, nothing could be better; but we doubt if many hard-headed, close-fisted buyers have been converted by these harangues. The people whom we want to convert, unfortunately, do not attend lectures, nor do they read technical papers unless somewhat compulsorily, hence the extreme difficulty of starting any scheme for *their* benefit in this direction. We intend that the buyers of power in a district wherein it is intended to erect a power station as soon as possible shall at any rate have an opportunity of reading these lines.

Putting aside for the moment the users of great quantities of power, and restricting our remarks to such people as printers, carpenters, grocers, tailors, etc., it may be taken for granted that their require-

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ments vary from a ¼ h.p. to 10 h.p. In by far the larger number of cases rent is a considerable item in the annual expenditure, and every available inch of room is utilised. This is especially the case among the printing fraternity around Fleet-street. Numbers would be glad to see a way to get more room without greatly increasing their rent. Their machine-rooms are crammed with machinery driven by gas or steam. The space occupied by the gas or steam motors could be made available for another printing, folding, or cutting machine, and these would furnish another source of income. As a matter of fact, no special floor space need be set apart for the electric motor or motors, for one could be affixed above-head or to the framework of the machine, where no moving parts interfered, or underfoot. Taking that a quad demy Wharfedale machine would require 1 h.p., the space required for the motor would not be more than 18in. by 8in. by 8in., the weight of the motor being, say, 110lb., more or less. So far as steam is concerned, a large number of printers have abandoned it; and so far as gas is concerned electricity is not going to interfere with that as a motor, except in certain localities and under certain conditions. The principal condition is where the space is badly wanted for other machines. We are well assured by those whose experience is greater than our own that electricity is cheaper than gas, both initially and for maintenance. Any printer obtaining his power electrically should stipulate with the electrical engineer who installed the motor that the electrical energy should cease when the machines stopped running—that is, that expenditure stopped the moment it was not wanted. This is absolutely impossible both with gas and steam. In the former case you stop the machine, but the gas-engine runs and is consuming gas all the time, though perhaps in less quantities. This waste, however, has to be paid for, and enhances the cost of maintenance. With steam, coal must be consumed both when getting up steam and during stoppages in working. So far as attention is concerned, the electric motor requires far less than a gas-engine, and none in comparison with a steam-engine. No matter what the power motor used, the services of a "stoker" can be dispensed with. Then nothing can well be more cleanly. The only dirt that can possibly arise is from the wear of the brushes and armature, and from the wasted lubricating oil. The latter would naturally be caught in the cups provided, the former would never be noticed. The use of electricity, then, is cheaper, it gives less trouble, permits space to be occupied with revenue-earning machinery, is cleaner, and there is less noise. The good properties we have enumerated are only obtained when the power is generated at a central station, and are not to be found by the user of the horse-power, if he sets to work to obtain them electrically with his own plant. Printing machinery only has definitely been mentioned in detail, but the remarks apply equally well to sewing machines, coffee mills, wood-working machinery, etc. In every case there is the immense advantage that directly the revenue-earning machine stops, the expenditure for power stops, yet it is always ready, and can be turned on at a moment's notice. There is absolutely no danger to health or life attaching to the use of electricity in this direction, nor is there anything like the risk of fire which arises with the use of steam or gas. Many users of power accept—and very rightly so—without question the fact as put before them, that though their steam-engine may be only 10 h.p. nominal, it should really be run at about 30 h.p. actual to give the best results. As a rule, a sudden demand upon a steam-engine is always squarely met, while a similar demand upon a gas-engine would pull it up. An electric motor in this direction partakes somewhat of the character of a steam-engine, and you may greatly overload it and obtain surprising results—momentarily. The demand must not be a long-continued one, or there will be a failure to respond. To parody Shakespeare—There is nothing in heaven or earth, dreamt of in our philosophy, which offers so great advantages to users of small power as electricity, though as yet its general adoption around any one station is a consumation to be fervently desired.

ELECTRICAL ENGINEERS.—IV.

THE INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

By far the largest electrical works existent in this country are those of the India Rubber, Gutta Percha, and Telegraph Works Company. These works are situated on the banks of the River Thames, at Silvertown; and this position at the water edge, and near to the railway station of the Great Eastern Railway, affords great facilities for the despatch of goods both by land and water, as a branch from the railway comes directly into the works.

The property covers about 17 acres of ground, the works being disposed in blocks of buildings according to the various departments. In full work upwards of 2,000 hands are employed, in addition to some 300 or 400 men on board their steamships—the wages paid annually to the workpeople alone amounting, we are informed, to about £100,000. The four vessels belonging to this company, the "Silvertown," "Dacia," "International," and "Buccaneer," are all fitted with cable-laying machines for submarine telegraphy, and have a total carrying capacity of about 12,000 tons. The whole works are practically divided into two main departments—the indiarubber and electrical departments. Of the first, which includes the ebonite and other departments, it is not within the scope of this article to describe, and we propose confining our attention to the electrical part. The submarine telegraph departments, instrument, torpedo, and battery departments are probably well known to most of our readers, and we will content ourselves with merely enumerating them, although it should be borne in mind that each of these departments is as large as many an ordinary factory, the number of hands employed giving no idea of the size where labour-saving appliances and automatic machinery are largely used.

The head offices of this company are at 100 and 106,

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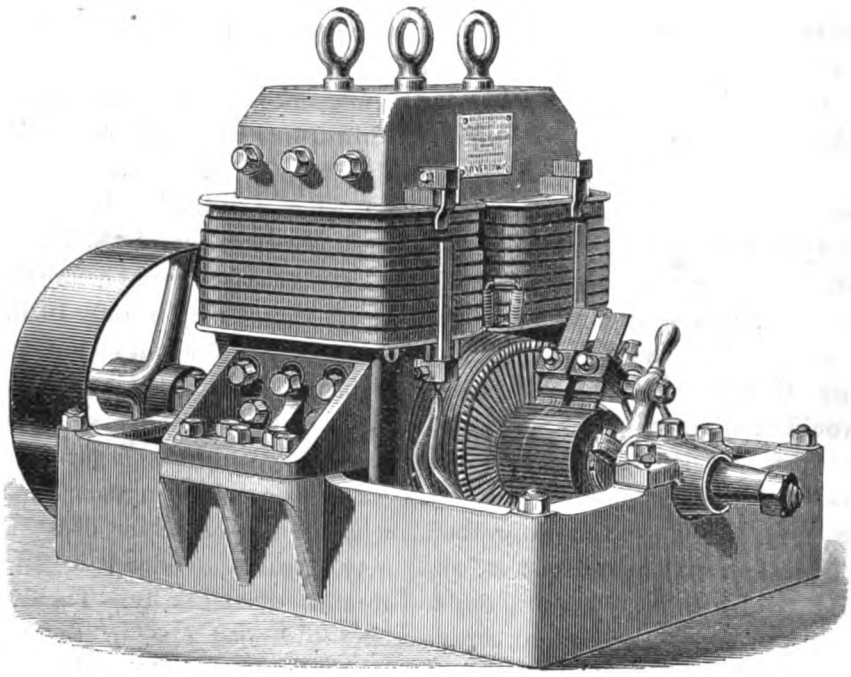
Cannon-street, London, and at 97, Boulevard Sebastopol, Paris.

Of the Silvertown Works, as before stated, a proportion only is for electrical work proper, but it will be seen that the India Rubber Company, both as regards their manufacturing facilities, their business organisation, and, perhaps not least, their strong financial position, are especially able



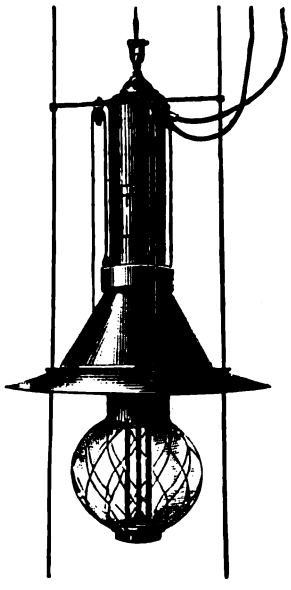
Silvertown Two-pole Dynamo.

to undertake large electrical engineering work such as we are now looking forward to as likely to extend both in England and elsewhere. For this they are fully qualified, having always been noted for the excellence of their electrical work and the skill of their electrical staff; indeed, at their own factory they have a sample of this class of work, as they have probably one of the largest private lighting installations in daily operation, consisting as it does of some 150 arc lamps and nearly 2,000 incandescent lamps.

Passing at once to the shops dealing more especially with electric light, we come first to the

Electric Light Lead Shop.

The branch in which most work is being done at present is that of electric light leads, cables and wires for installa-

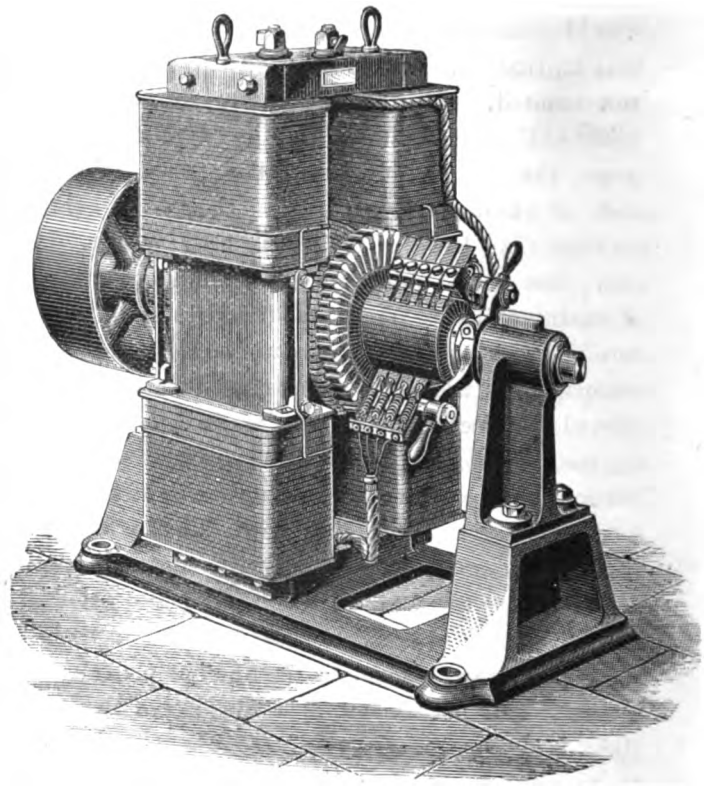


Silvertown Outdoor Arc Lamps.

Silvertown Indoor Arc Lamps.

tions, such as supplied to the trade generally. In this department everything is manufactured in the works, with the exception of the copper wire. The working up of the indiarubber from the raw material enables tests of comparison to be properly made from an electrical as well as a mechanical point of view. For the copper wire, tests are made on each delivery, and although these wires are only guaranteed to 96 per cent. conductivity, there would be no difficulty in guaranteeing 98 per cent. if so required.

The insulated leads generally supplied are of three classes—1st, pure rubber insulation; 2nd, unvulcanised rubber insulation; and 3rd, vulcanised rubber insulation. With the last class the India Rubber Company have for some years been engaged on experimental work, and having satisfied themselves that such cables can be made of practically any size at a very slight increase of cost, and that such cables have a decided advantage, if properly vulcanised, over any other class of cable for durability, both mechanically and electrically, the company have accordingly made



Silvertown Dynamo.

them an important item on their list, and laid down extensive plant for their manufacture.

The processes of insulation are as follows:

1st. For the pure rubber class, rubber of the best and most lasting quality—namely, Para—after being thoroughly

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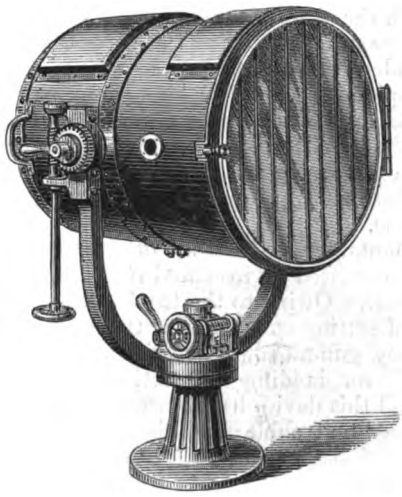
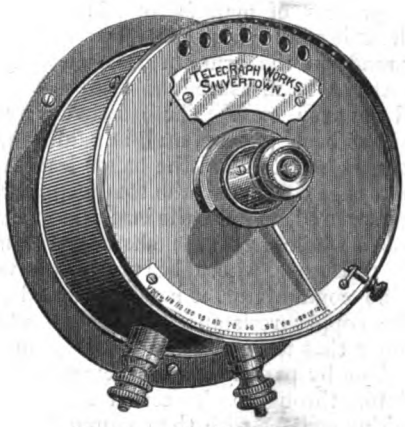
cleaned, is run into sheet and cut into strips, which are wound on bobbins in a long continuous length, the process of jointing being a simple one—viz., the ends are snipped off clean, and then hammered together; no cement or solution is required, the joint thus made being perfect. These bobbins of rubber are mounted on a covering machine, through which passes the single wire, or stranded tinned copper conductor, covered with one or more layers of cotton. The rubber is then applied spirally to the conductor, generally in two layers applied in reverse directions. The insulated wire is then covered with one lap of prepared tape and braided over all; then passed through a bath of composition and colouring matter to fill up the pores of the braiding. The object of the layers of cotton applied to the tinned copper wires under the rubber



Silvertown Projector.

is to protect the insulation, and for the same reason the prepared tape is applied over the rubber to prevent all chance of the threads of the braiding cutting through the rubber. Of course, in the manufacture of this class of lead much depends on the quality of rubber, and although a cheaper quality could be used, which would present to the uninitiated the same appearance, still a considerable difference would be found in the comparative durability.

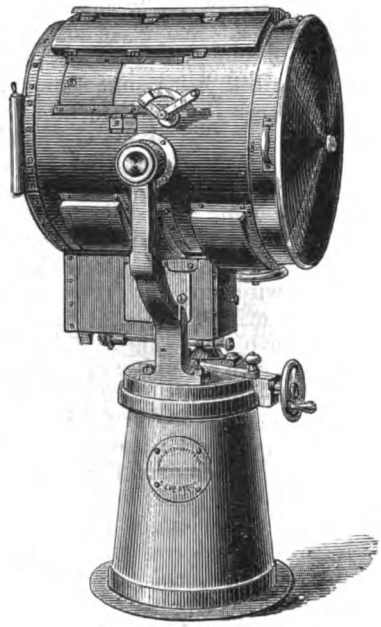
2nd. In the second or unvulcanised class, the process is as follows: The rubber, after being carefully cleaned, is mixed with pigments and rolled into sheets of considerable length; these sheets are then cut into strips of the desired



Silvertown Wall Voltmeter.

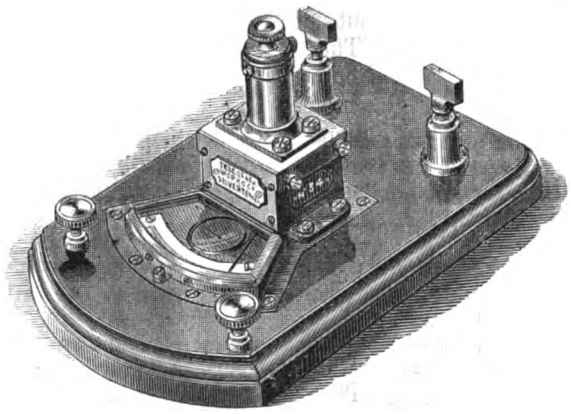
width and taken to the rubber-covering machines, and there applied under great pressure to the copper conductor, which has previously been passed through a machine to receive a protection, supplied in the form of a spirally lapped tape. One, two, or three strips of rubber are put on as the thickness of insulation may demand, and the wire so covered is afterwards taped and braided, and then passed through a bath of preservative composition. In this process great care and skill is necessary in producing such a rubber as will efficiently meet the many and varied trials to which such a cable must necessarily be subjected.

3rd. In the third or vulcanised class, the single or stranded tinned copper conductor is first passed through a lapping machine, where it is covered with one or more spiral coats of pure Para rubber, after which it is taken to the rubber-covering machines, where a first coat of pigmented rubber is applied, this coat being known as the separator. Another coat is then superposed, and the cable is finally lapped with tape before undergoing the process of vulcanisation. This process consists of submitting the cable to a temperature of about 300deg.F., this heat being found sufficient to bring about a chemical change known as vulcanisation, which takes place between the



Silvertown Projector.

sulphur and the rubber. This sulphur has been previously mixed with the rubber and every precaution taken neces sary to ensure an absolute uniformity of mixture, as on this depends the success of the process. For the manufacture of this class of cable it is necessary to be intimately acquainted with the physical and chemical properties of the various pigments used, so that by a judicious choice of these pigments the resultant vulcanised cable will more readily withstand both the physical and chemical changes that may take place owing to the application to which the cable may be put. After vulcanisation the cable or wire is then braided over all with a strong flax braiding, and



Silvertown Ammeter.

passed through a bath of composition to fill up the interstices of the braiding.

From the foregoing it will at once appear that for the vulcanising process great care must be taken in the selection and mixing of the rubber, the application of the coats, and the time and temperature of the vulcanising. Rubber so treated resists to a great degree the attacks of most acids and oils which would affect the unvulcanised rubber, and will not be affected after vulcanising by high temperatures, say, 400deg.F., as would the pure rubber and unvulcanised classes; and it is therefore very suitable both for underground work, or in places where it may be subjected to high temperatures.

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Lead-Covered and Armoured Cables.

For damp situations and underground work, as previously stated, the vulcanised rubber insulation is superior to the others; but in many cases further mechanical protection is required. This is generally obtained by covering the insulated cables with lead drawn down on them by means of dies, or by sheathing the cables with iron wires in a similar manner to that used for submarine cables. When, however, in underground work the cables are placed either in a concrete trench, wood trough, or iron pipe, such protection is not really needed, a strong tape over the braiding being all that is necessary to protect the cable against risk of abrasion from inequalities in the pipes, etc., and the lead being unnecessary, except for mechanical protection, when vulcanised cables are used.

With regard to this question of underground conductors the India Rubber Company states that for all the work done with cables for both high and low voltages, although some have been in use for a good many years, they have not a single case on record of a failure when the cable has been made with a knowledge of the conditions of working, and has been laid underground with reasonable care.

Cotton-Covered and Flexible Wires.

In this department are a number of small machines for winding and braiding, in all about 120, which are used for the covering of wires with cotton for bell and telephone wires, or for use in winding the armatures and magnets of dynamo machines. Here also are the stranding machines for making flexible wire. We noticed one fitted with 300 bobbins for the manufacture of flexible cables for portable cargo lamps or brush connections on dynamos.

In addition to the above, many special cables are made with concentric conductors, insulated with vulcanised or unvulcanised rubber according to circumstances.

Testing of Cables.

As might be expected in these works, the system of testing is very complete, each department having a testing-room or rooms to itself, fitted with all the necessary galvanometers, electrometers, resistances, batteries, etc.; wires being led from the various machines and tanks to these rooms to enable tests to be taken at any time during manufacture.

A special staff is retained for this work, and copies of all tests are kept for reference. For the electric light cables all the tests are taken after 24 hours' immersion in water and with a difference of potential of 500 volts, conditions which are calculated to show up any mechanical defects in the insulation, and as the specific resistances of the various classes of rubber are known, any falling off in the quality or defects in the application of the insulation can be detected by the final tests not coming up to the calculated standard.

Leaving now the cable and wire departments, we come to those devoted to the manufacture of dynamos, lamps, switches, etc., and, as most important, we will first describe

The "Silvertown" Dynamos.

The India Rubber Company are now making dynamos of both the double and single horseshoe types, in all cases using a modified Gramme armature.

In the larger machines, the field-magnets are built up in such a manner that one side of the machine may be removed, and the armature drawn out sideways, so as to avoid all chance of damaging the coils. The magnet-coils are wound on separate bobbins, slipped on over the iron cores; and the wires on each bobbin are brought to terminal blocks carried on its flanges, the connections between the several bobbins and the terminals of the machine being made by copper strips, which are easily detached should it be necessary to test or remove a bobbin separately.

An example of each type is shown in the accompanying illustrations; the double horseshoe machine being for 27,000 watts at 600 revolutions, and the single horseshoe machine for 20,000 watts at 550 revolutions. This latter type is used chiefly coupled direct to a high-speed engine, in which case the bearing at the pulley end is dispensed with, and the dynamo-shaft rigidly coupled to that of the engine.

The construction of the armature used in these machines may be briefly described as follows: The copper coils are wound by hand on the core, which is generally built up of soft charcoal iron wire, and is carried on a gun-metal centre which connects it with the driving-shaft. The iron cores are wound up in special lathes, so arranged that five or six wires are wound on at the same time; the wires passing through a die, carried on a slide rest, worked by a traversing screw, which is set to give the right pitch for the number of wires employed, and thus winds them regularly on to the gun-metal centre. This latter is fitted on a cast-iron mould so as to make a complete cylindrical surface for the wires to lie up on.

In the smaller sizes, say, of 10in., or less, diameter, the iron core is wound in the same manner on a cast-iron centre, which can afterwards be withdrawn; and the copper coils are wound on before the centre—which is to connect the coil with the shaft—is put in place, the object being to leave more room for threading the wires through the *inside* of the cylinder. These smaller armatures are *carried on* gun-metal spiders fitted with shoes which can be *adjusted* radially; leather bearing-pieces are placed between the shoes and the wire, and the shoes are moved outwards by screws from the centre until they hold the coil firmly, after which they are finally adjusted in the lathe till the coil runs perfectly true.

The commutators are built up of copper insulated with mica, and are carried by insulated rings on a sleeve, bored to fit the shaft. Owing to the trouble caused by the rings of insulation getting out of shape, the company have been led to employ gun-metal rings with a coating of ebonite "cured on," for holding the sections of the commutator together, and this device has answered perfectly, as with it there has been no trouble from the insulation cracking or getting out of shape, and so rendering the whole commutator untrue.

The company are making these machines to standard patterns, either shunt-wound or self-regulating, with outputs from 1,500 to 36,000 watts for incandescent lighting; series wound for lighting from 3 to 16 arc lamps, or specially wound for supplying current for search lights of the usual candle-powers. They are also using the double horseshoe type for motors for traction and other purposes, making some slight modifications in the general arrangement to suit the particular positions in which the motors work, and strengthening some of the moving parts to meet the increased strains to which they are sometimes subjected.

Particular attention has been given by this company to the question of testing, and it may be interesting to briefly detail the tests which they have found it advisable to make during the process of manufacture, in addition to those made by the coil winder himself. As soon as the copper coils are wound on the armature, the insulation between adjacent sections is measured, as also that between each section and the iron core. These tests are repeated after the bands have been put on, and, in addition, the insulation between the sections and the bands is measured. After the commutator is connected, the total copper resistance of the coils is measured, and also the insulation resistance of the armature as a whole, from the shaft and iron core. For coils of low resistance, where heavy wires have to be connected to the commutator, it has been found advisable to measure the copper resistance of the separate sections in such a manner that the resistance of the joint is included; and this is done by passing a steady current from a battery of accumulators through each section in turn, by means of brushes making contact with the commutator sections, and measuring with a reflecting galvanometer the difference of potential between these sections at points intermediate between the brushes and the joints. By this means, any faulty joint or short circuit, should there be one, can at once be discovered, and put right before the armature is put in the machine to run. The magnet bobbins are tested for copper and insulation resistance before being fitted on the machine; and when the machine is complete, it is then run for five or six hours at full load, measurements of speed, E.M.F., and current being made at intervals during the trial.

Arc Lamps.

The "Silvertown" arc lamp, which is regulated by a magnet actuating a detent which controls a train of wheels,

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is neatly arranged as shown in the accompanying cuts; for indoor use it is generally fitted with an egg-shaped opal globe, and suspended by means of an insulated eyelet on the top of the frame, whilst for outdoor use it is fitted with a reflector and weather protector. The globe is balanced by a counterweight, for convenience when trimming and cleaning, and the usual gear for raising and lowering the lamps is supplied.

Search Light Projectors.

The two types of projector usually made are shown, one mostly constructed of iron and suitable for use on land, and the other, a more costly form, suitable for use on board ship and in exposed positions. These are usually supplied in

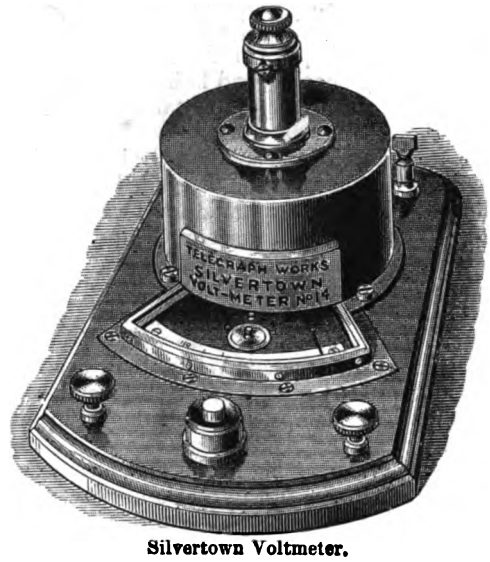
Silvertown Testing Set.

sets, with their own dynamos, and are sent out completes with lamps, conductors, tools, carbons, etc.

Measuring Instruments.

The company are making voltmeters and ammeters of their own design, both being spring instruments, as they are satisfied that these are the most reliable for installation work, when care is taken to select a good spring to start with. Instruments for use on a table, as the ammeter and voltmeter shown in the cuts, are fitted with levelling screws and a spirit-level; and similar instruments, but without levelling arrangements, are made for fixing on a wall. The larger voltmeter of this class, shown in the cut, has been specially designed for places where it is in fairly constant use; the large surface exposed, and the arrangement of ventilating holes in the case, rendering the error from heating comparatively small. This type has been found very suitable for use on board ship, as it can be made very dead beat, and will work in any position.

In addition to these instruments, the company has brought out, for use in connection with electric light installations, a very convenient portable testing set, of which we give a perspective view and a diagram of connections. It is contained in a polished teak box, about 7in. square, and weighs about 8lb. It consists of a compact Wheatstone bridge, with dial pattern resistances of tens and units, and ratios of 100 to 1, up and down, so that it is capable of measuring copper resistances between 9,900 and ·01 ohms. It has a high-resistance sensitive galvanometer fitted with $\frac{1}{9}$ and $\frac{1}{99}$ shunts, and a galvanometer key. For measuring insulation resistances it has separate battery, earth and line-wire terminals, and is fitted with a 10,000 ohm coil for taking the constant of the galvanometer. It has been specially designed for the purpose of enabling reliable and complete tests to be taken on an installation with a really portable instrument which is not likely to get out of order, and, with the portable battery supplied with it, it makes a complete testing



Silvertown Voltmeter.

set which cannot fail to be exceedingly useful to electrical engineers. The battery usually supplied consists of 30 Leclanché cells of special pattern, contained in a polished box 9in. by 7in. by 11in. long, and fitted with terminals, so that 10, 20, or 30 cells may be used.

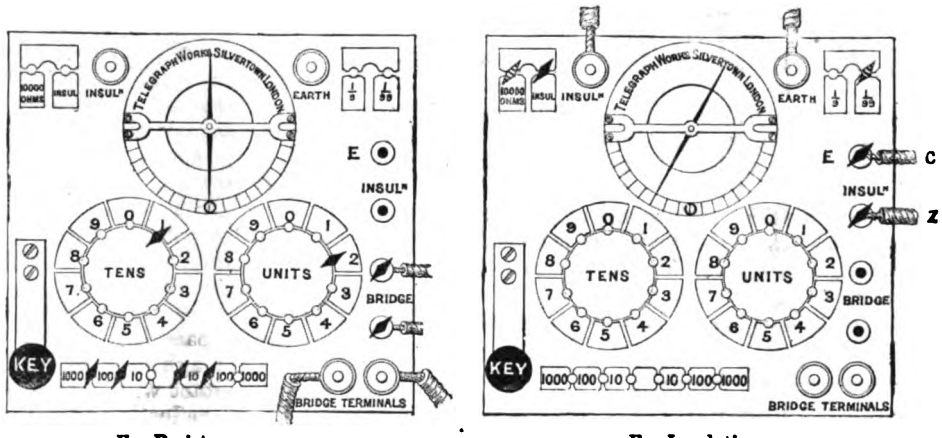
The various parts of the apparatus described above are made in several shops, of which we propose to give a brief description.

Machine, Smiths' and Carpenters' Shops.

These shops are not entirely devoted to the manufacture of electric light plant, as they also supply whatever is required for the other departments in the factory.

The machine shop is a large building, containing a good collection of lathes, planing, slotting, boring, and milling machines, and here the iron frames of the dynamo machines, sliding beds, and the heavier parts of other apparatus are machined, and are then sent to the electric light shop to be fitted and erected.

In the carpenter's shop all the grooved casings, mouldings, etc., are made, special machinery being employed for this purpose, and also the baseboards and boxes for



For Resistance. For Insulation.

Diagram of Connections of Testing Set.

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switches and instruments, and many other sundries in woodwork which may be required.

ELECTRIC LIGHT SHOP.

This is a large three-storey building, in the ground floor of which are placed most of the dynamo machines for lighting the factory. These machines are driven, through countershafting, from two compound engines of the semi-fixed type, with multitubular boilers, which are placed in an engine-house built at one end of the main building. These engines, each of which is capable of indicating 120 h.p., are also used during the day for testing the larger dynamo machines before they are sent out.

The lighting plant occupies the central bay of the shop for its whole length, and on one side of it are placed the iron wire winding lathes, and some small screw cutting lathes, driven from the shop engine; and also fitters' benches for use in erecting the dynamos when they come in from the machine shop. On the other side of the shop are the coil-winding benches, and lathes for winding magnet bobbins; and here also the commutators are connected to the coils of the armatures.

In the middle floor of the building the brass-finishing and electric light instrument making is carried on, including the making of brushholders, commutators, terminals, switches, switchboards, voltmeters, ammeters, lamps, etc. On this floor there is a horizontal engine, which is used for charging accumulators and for testing the smaller dynamos; and here also are the offices, photometer, and testing-rooms. These latter rooms are well fitted up with adjustable resistances, reflecting galvanometers, Wheatstone bridge, electrometers, and all other requisites for testing and calibrating the various machines, lamps, and instruments made in this department.

One feature worth noticing in the arrangements for the reflecting galvanometers, in this and other testing-rooms in the factory, is that incandescent lamps have replaced the usual oil lamp in all cases. The lamps used have a very short filament, so as to throw a good image on the scale, and are all run off a special set of accumulators, each lamp being controlled by its separate switch; an arrangement which is appreciated by those working in the testing-rooms.

The top floor of the building is used as a store for the finished material required for installation work; and in a separate part of the shop are placed the battery of accumulators which is used for supplying current for testing and calibrating, and that for lighting the galvanometer lamps.

The three floors are served by a lift worked by the shop engine, so that there is no difficulty in transferring material from one floor to another.

From the descriptions given it will be seen that these works are extremely well fitted and are very complete in themselves, so many affiliated branches of electrical work being carried on under one management. A factory, employing about 300 hands, situated at Persan-Beaumont, near Paris, is also carried on by the company, where, amongst other things, a considerable amount of electric light cables and wires is manufactured.

To cope with the large volume of business which they have, the company has found it necessary to establish a large number of agencies, and it now has one in nearly all the important towns in the United Kingdom, and in every country in Europe, besides branches in Calcutta, Melbourne, Sydney, and Buenos Ayres.

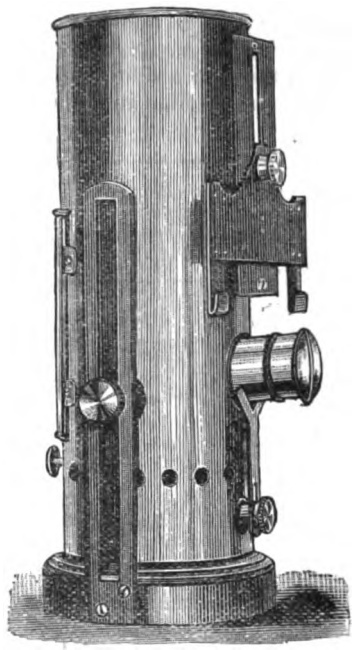
ADDENBROOKE'S REFLECTING GALVANOMETER.

We illustrate herewith a reflecting galvanometer by Mr. G. L. Addenbrooke, made by Mr. J. J. Hick, of 8, 9, and 10, Hatton-garden, which we think may prove useful to our readers. The instrument is very neat and compact, being only 5in. in diameter. A spirit-level is set on the top of the case, and the case itself can be readily lifted off, exposing the interior coils. Both bobbins can be readily taken out without disturbing the needle, and there are no awkward connections to get out of order. Several pairs of bobbins for various testing purposes can be made and fit the same instrument, so that they can be interchanged at any time desirable.

The suspension is by a long silk fibre wound round an ebonite rod, which is provided with milled heads. The fibre may be a yard long if desired. The ebonite rod is then turned, winding the fibre round it until it (the fibre) is about the right length, and then the ebonite rod is slipped into its place. The fibre then, if it is wound the right

Addenbrooke's Reflecting Galvanometer.

way round the rod, at once automatically centres itself, and by rotating the rod the needle can be set exactly. By this means a long suspension is secured, and, if it is desired, several rods and needles can be kept for different purposes. It will readily be seen that attaching a new fibre is a very



Addenbrooke's Improved Lamp.

simple and short operation as compared with that necessary with the ordinary type of instrument. The needle itself consists of a stiff aluminium wire carrying the magnets and mirror.

For all ordinary testing work, it is best to use a damper on the needle sufficient to prevent long swinging and annoying vibrations without rendering the instrument dead and sluggish. This damper works in a little glass jar, fixed

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in the base of the instrument. The jar has its edges turned over to prevent the liquid (paraffin or glycerine) being spilled when carried about. A second pair of coils, on the same principle as the two in the instrument, can be added if desired.

The lamp is shown in the second illustration, and consists of a copper tube 4½in. diameter, 12in. high. A funnel is provided on the top, by means of which the lamp can be quickly filled. It is so made that the longer axis of the flame and the axis of the lens or slot should coincide, and that the intensest part of the flame should be opposite the centre of the lens. The height of the burner is also carefully adjusted to be right when the lens is in a horizontal position; and to allow the lamp to be used in various positions.

A specially portable scale and shade is made for use with this lamp, which is made to fold into half its length.

For carrying about or putting on one side, a box is arranged to take both galvanometer and lamp, with room for shunts and other accessories. The size of this case is rather less than is required for the ordinary pattern of lamp and scale alone.

CABLE v. ELECTRIC.

The *Street Railway Journal* gives a poem, by Mr. B. F. Haughton, read at the Ohio tramway meeting referred to elsewhere, of which we extract two or three verses, which contain the hits against electric traction. The poem is entitled

YOU NEED NOT CALL ME EARLY.

You need not call me early
To-morrow, mother dear;
I do not have to rise as soon
As I did this time last year;
For then I had to "hustle"
And "hump myself" you know,
For we lived on Walnut Hills, mother,
And Kerper's cars were slow.
Yes—Kerper's cars were slow, mother,
And *open* all the year;
I don't forget the awful colds
I caught there, mother dear.
* * * *

Last night I had an awful dream;
I wakened in a fright;
I thought we were condemned to use
Electric cars that night.
The people tear their hair, mother,
Who use the electric line
That Kerper runs to Avondale,
And swear, and kick, and whine.

When cars are off the track, mother,
The wires crossed or down,
The brushes burned out badly;
And all the way to town
Halting for some repairs, mother,
Or stopping altogether,
Passengers oft turned out to walk,
No matter in what weather.
* * * *

ELECTRIC TRACTION.*

BY A. G. CLARK

In attempting to comply with the request that I should prepare a paper on the subject of electricity as applied to street-car propulsion, it must be accepted at the start that I present the matter as a layman, and not as an expert, or one versed in electrical science.

My experience began with the construction of the Baltimore and Hampden road in 1884, probably the first practical application of electricity to a road doing regular business. The fundamental principles developed in its construction are essentially the same as of to-day, the advance being made in mechanical detail and construction. It is hardly worth while for me to recite the various methods that are being experimented with. The only one known to me which has answered every requirement as to economy, changes of weather, etc., is the "overhead system." I do not know where storage batteries have been operating an entire road; and to-day, if acknowledged a success, it can only be considered so when operated in large cities, on account of the large operating expense. As electricians tell me there has been but little advance over twenty years ago in the results produced by storage batteries, it is to be hoped we are approaching the time when some great discovery will be made which will make them applicable to all street cars—there is no doubt this will be the perfection of street railroading. Several examples of underground construction are now in operation, but I know of none that have stood a winter test, without it be a road in California, where the construction cost from thirty to forty thousand dollars per mile, and where the conditions of climate afford us no opportunity of forming an opinion. If to-day we are to judge of the practical operation by electricity of street cars, in all its phases, there is really nothing, in my opinion, but the overhead system. All the various plans for constructing plants of this character are essentially the same—generating a current at a station, of about 500 volts, which is transmitted to a wire or wires, varying in size and number as the voltage may be more or less. I do not go into a description of the construction, as I imagine every member present has seen electric roads in operation—it is more my purpose to make statements and suggestions which may be of benefit to those contemplating the adoption of this power.

In the first place, do not try cheap and inadequate construction; there is no place where economy can be so misapplied, for electrical machinery cheaply and poorly constructed is a most constant source of annoyance and expense.

Second. Start out with the knowledge that you will duplicate every part of your machinery, both steam and electrical, as the most perfect of mechanism may fail, and nothing is more annoying to the travelling public than delay. In addition to this, you are repaid in the economy of operation and the saving of your machinery, as the non-crowding of boilers saves coal, and the changing off of machinery gives it a rest which is most desirable, especially to the electrical part, giving it a chance to cool, and saving many a burn-out.

Third. Cleanliness is essential to satisfactory operation. The motor-drivers should be required to keep their motors free from oil and dirt, and everything that tends to this end should be provided for them. A pit should be conveniently located, so that frequent inspection can be made of the gearing. All electric roads should have extra cars, not only in case of accident, but that in rotation the motors may be inspected, and taken apart and cleaned of oil and any copper dust from the wearing of the brushes. With proper care and system, I have no hesitancy in saying electric roads can be run economically. Of the two methods of over-running and under-running trollies, I would decide in favour of the latter, because there is not the weight and strain on the wire, nor is the trolley constantly falling on top of the car; also, in case of sleet, the water has a tendency to form in icicles on the under side of the wire, which the trolley wheel will knock off, while on top it forms a continuous non-conducting surface of ice, which must be broken to obtain a contact. The leaning of electric railroad constructors seems to be all towards placing the motors under the car, and making connection by cog-wheels to the axles. In view of this, I have some hesitancy in saying my preference, except in case of heavy grades, is to have motor in front of car, for the following reasons:

First, it gives a better opportunity for the man to keep them clean.

Second, being always in sight, any tendency towards electrical difficulty can be checked at once, thereby often saving an armature or commutator.

Third, my experience has been that the motor-drivers become attached to their special motors, like a locomotive engineer to his engine, and take pride in keeping them in order.

Fourth, the motor is out of the way of all chance of getting wet or dirty, or magnetically attracting nails or iron material in the streets.

When there are any considerable grades, the more direct method I should consider of advantage. If very heavy grades are to be overcome, a special "tow car" would be of benefit rather than have weighty and expensive equip-

* Paper read before the Ohio State Tramway Association, as reported by the *Street Railway Journal*.

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ment on each car to simply meet the requirements of certain grades.

Before beginning to build a power-house, great study should be given to the location of machinery in the building, for if this is done properly quite a saving can be made in expenses of operating.

I believe an observance of the points I have so crudely made, as they are regarded or not, will tend very decidedly to make or mar the success of electric roads.

Mr. Rodgers desired that Mr. Richardson, of Brooklyn, who was present, be requested to state what progress was being made with electric motors in Brooklyn.

Mr. Richardson thereupon said that the Brooklyn City Railroad Company had interested itself sufficiently in the subject to allow the use of its Fort, Hamilton-road, for the trial of electric motors of two kinds, one being the "Main" motor, so called after the inventor's name. He believed, however, that neither was in continuous operation, and that both had made only trial trips, which were only in part satisfactory. As he had seen neither of these motors, he could say nothing as to his personal knowledge of them. They were, of course, independent motors, known as the storage battery class. Mr. Richardson further said that he supposed the progress that was being made with the Julien motor on the Fourth-avenue-road, in New York city, was known to almost all present. The company had started with one car, and proposed to increase to ten, which had been ordered; and two or three of which, he had been informed, were in operation with more or less regularity. Mr. Richardson said that the East was looking to the West for improved motive power for quick transit on the surface, while he personally believed that the problem had been already solved by the cable power for large city roads with enormous travel.

Mr. Clark resumed the discussion on electricity, and stated that the great trouble with the underground construction was that the expenses were so high that the cable system might as well be used. He said his experience in Dayton had brought out one incidental advantage of electric power that had not before been thought of—namely, the ability to back up the car to take on passengers. He referred to the great loss of power in the use of the storage battery car, and also to the increased weight, necessitating the reconstruction of many lines for its use where a side-bearing rail was used. He thought the question of motive power could be more profitably discussed by dividing roads into two classes: one, those where the cable system can be afforded; the other, those too small to afford it. In reply to a question by Mr. Clegg, he said that in building again he should use a rail heavier than the present one in Dayton, that being 38lb. Johnson, though nothing had given way there to cause that impression. He referred to the fact that in Dayton he had two engines, either one of which was capable of running the road, and cited the instance of the break of one of the engines, when it took just 13 minutes to couple on an extra engine. He also had an extra boiler and one dynamo more than was necessary to run the road. He said that nine cars were constantly in operation, and were giving entire satisfaction. One car was constantly under inspection, not so much to repair defects, but as a precaution; and the road was being operated with entire success. Since it was turned over by the builders to them, no trouble had been experienced; some little difficulty, however, was first encountered in crossing the steam road, where 26 single rails had to be crossed, on account of the jar to the trolley. This had been obviated by the construction of a sort of steel arm, which had a spring at the point somewhat like a whip. He preferred the under-running trolley, as it was less liable to leave the wire and did not cause additional weight on the conductor, or, in case of ice, freeze on to the wire. He thought it was much more apt to freeze in icicles on the under side of the wire, and these would readily be removed by the trolleys. With regard to the subject of economy, he replied to a question that, with careless treatment, he considered electric power the most expensive, but with care it was very economical.

Mr. Brownell referred to the success of the Sprague electric road at St. Joseph, which had been converted from a horse-road; no delays were experienced, and cars were run as fast as 25 miles an hour. He referred to the shallow conduit cable road now in course of construction at Butte City, which shallow conduit greatly reduced the expense of construction, and said on the "level" part of the road the grade was 6 per cent.

Mr. Doherty, of Cincinnati, said there were some who believed that electricity had passed the experimental stage, and that it might therefore be adopted by a wise and cautious railway manager, and that he incurred very small risk. It was reasonably sure that electricity in some form would be used, and those adopting the overhead conductor, in case the storage battery was later adopted, would only lose the inexpensive part of the construction—namely, poles and overhead conductors. He thought that companies should adopt systems without so high a potential as would endanger life. The most prominent companies now building roads did not require over 500 volts, which he believed was not dangerous. He also referred to the false public sentiment regarding the injury to watches and the danger to life.

Mr. Clark said that in Dayton the average power required on a level was from 3 to 4 h.p., and on curves 12 to 13 h.p., on a grade of 3½ to 4 per cent., 10 to 11 h.p.

AMERICAN FUN.

PRIMER OF ELECTRICITY, No. 0.

COPIED WRONG BY PROF. HOW'S-IT-DONE?

This Primer contains an immense amount of useless misinformation condensed in wonderful and unavailable form.

I. DYNAMITE ELECTRIC MACHINES.

Dynamite electric machines may be painted a great variety of colors without increasing their efficiency. This affords scope for aspiring inventors. A Dynamite consists essentially of the following parts, namely:

The Painted Portion or Chromosphere.
The Wiry Portion or Whirligig.
The Brassy Portion or Computator.

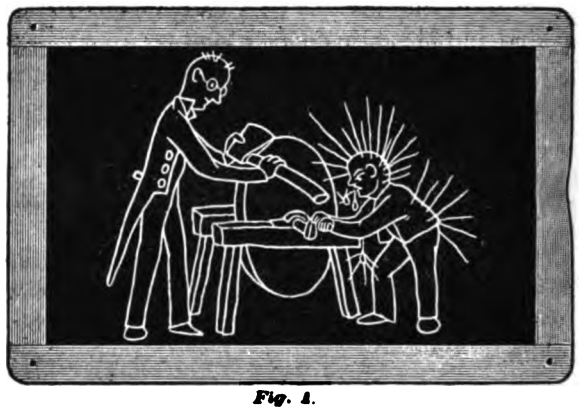

Fig. 1.

Fig. 1. Shows the most or'nery kind of a machine. The painted portion, or chromosphere, is attractively decorated, and thus electrifies the ten-acre lot or field in which the whisky-bility of the wiry portion displays itself.

When the crank is put in rapid rotation by a small boy under the normal conditions of this building, he immediately becomes incandescent, *i.e.*, red hot. This effectively illustrates the transformation of energy.

The electricity of dynamite machines is due to the seductive influence of the painted portion upon the wiry portion through which the current divigates until it would be entirely lost in the mazes of its own insignificance, but that a large portion escapes into the ark through the brassy portion, technically termed the computator, because it is here that the percentage of alleged efficiency is worked out, and where a dazzling light of a pale green color is reflected in the eye of the bewildered spectator.

N.B.—Negotiations are pending with Mr. Noah for the extradition of the electric current hidden in the ark.

The wire as well as the common sense of the visitors must be insulted at every turn.

II. ELECTRIC LIGHTS

There are two kinds of electric lights, namely:
Our kind and *the other fellow's* kind.
Our light is much lighter than the other fellow's light.
The other fellow's light is surrounded by a cloud of non-luminous verbosity.

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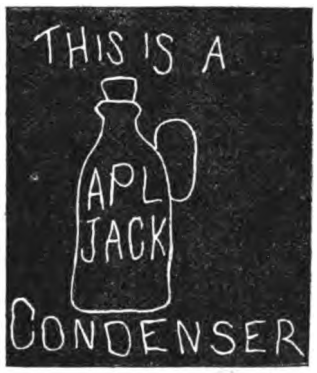
III. ELECTRICITY.

The identity between lightning and electricity was discovered within a convenient distance of this building by Benjamin Franklin.



The identity between Jersey lightning and applejack was probably discovered by his son William, whilst Governor of that Province. This may also be demonstrated at a convenient distance from this building by those who wish to try it.

The properties of the electric current, therefore, will be best appreciated by the class of persons who visit this Exhibition by considering the well-known effects of applejack.

1. *Heating effect.*—A good draught of applejack blisters the throat, and produces a genial warmth throughout the entire system.

2. *Luminous Effect.*—This develops at the end of the proboscis directly as the 6th power of the quantity and strength of the fluid until it assumes a *light* red.

Formula. $L = \frac{(N V)^6}{T}$

where L is the luminosity.
N the number of glasses.
V the volume of each glass.
and T the period of bibulation.

3. *Physiological Effects.*—We cannot do better than quote the words of a distinguished scientist, who says that: "When passed "through the human body it produces effects varying from" "violent spasmodic convulsions to agreeable tingling. When" "properly administered it possesses marked curative effects on" "the human body."

Ed. note.—We are sure this will be endorsed by all who have been there.

It is quite unsafe to touch receptacles containing applejack unless sure of your head in the morning.

IV. ELECTRIC CIRCUSES.

There are several kinds of electric circuses.

1. This exhibition is one kind of electric circus. The Jumbo exhibited is not that humbug of Barnum's.

2. The kids who infest the building daily are another.

3. So are the exhibitors who do not smother their *cusses.*

V. BATTERIES.

The essential part of the voltaic battery is the SELL.

There are many kinds of sell, the most important being:

1. This Primer, which is the most complete possible 2 *ct. sell* of its kind, and which supplies a long-felt want.

2. The storage sell, which is the *Faure*-most *Sell-on* record, and which has recently been *Brushed* up to *form* a new *Plant.*

N.B.—There is no *charge* for this *in-formation.*

3. D——sels. The Public School misses, with note-books and pencils. (This is a popular error, for every one will agree that there is no *Sell-on* here.)

NEW COMPANIES REGISTERED.

Electropathic and Turkish Baths, Limited.—Registered by Kerly, Son, and Verdeu, 14, Great Winchester-street, with a capital of £10,000 in £1 shares. Objects: To acquire the Turkish Baths, Station-approach, and Denman-street, Southwark, and two letters patent for improvements in electric baths, and for an apparatus for the administration of electricity to the human body in Turkish baths. The first subscribers are:

	Shares.
Alex. Kerly and Hy. Verdeu, 14, Great Winchester-street	1
J. J. Evans, 5, Ave Maria-lane, E.C.	1
M. Humm (electrician), 727, Commercial-road, E.	1
S. Sewell, 731, Commercial-road, E.	1
T. Gregoley, The Cottage, Limehouse	1
D. Elvin, 21, Andover-road, Hammersmith	1

The Lancashire Watch Company, Limited.—Registered by Chester and Co., 36, Bedford-row, W.C., with a capital of £50,000 in £10 shares. Object: To carry on the business of watchmakers, clockmakers, manufactures of electric bells, batteries and other electric apparatus, telephones, gas-lighters and regulators, medical and optical appliances, scientific and other instruments. The Company is registered without articles of association, and consequently the regulations of Table A in the first schedule of the Companies Act, 1862, will apply.

CITY NOTES.

Western and Brazilian Telegraph Company.—The traffic receipts of this Company for the past week amounted to £4,905.

Brazilian Submarine Telegraph Company.—The traffic receipts of this Company for the past week amounted to £5,917.

River Plate Telephone Company.—Holders of share warrants to bearer in the River Plate Telephone and Electric Light Company, Limited (in liquidation), are requested to send in their warrants forthwith to the liquidators, at the offices, 53, New Broad-street, E.C., in order that the payments due thereon may be made before the liquidation is closed, otherwise application to the Court of Chancery for payment will be necessary.

Swan United Electric Light Company, Limited.—Sixth annual report of the Directors, to be presented at the ordinary general meeting of the Company, to be held at the Cannon-street Hotel, E.C., on Tuesday, the 18th inst., at 12 noon: The accounts, which are presented to the shareholders, are for the year ending September 30, 1888. The business has increased on the Continent generally, and has resulted, after paying all current charges, and making fair allowance for depreciation of plant and machinery, in leaving a credit balance of £8,332. 1s., which the Directors will recommend shall be carried forward. The agreement with the Compagnie Continentale Edison, which was unanimously approved by the shareholders at the extraordinary general meeting held on June 5 last, was also approved by the shareholders of the Compagnie Continentale Edison, and has resulted in the formation of the Compagnie Générale des Lamps Incandescentes, which has its seat in Paris, and who are erecting a factory, with all necessary appliances for a large output of lamps to meet the established and growing demand. The litigation as to the Swan and the Edison patents is still dragging on in Germany. The negotiations between the Company and the representatives of the Edison patents in Germany have been dropped for some time, but the Directors will avail themselves of any fair opportunity which may be afforded of reopening the negotiations with a view to a satisfactory settlement in Germany. The Directors who retire by rotation are Mr. J. W. Swan and Mr. C. H. Stearn. Messrs. Quilter, Welton, and Co., the auditors, also retire.

PROVISIONAL PATENTS, 1888.

NOVEMBER 30.

17,479. **Improvements in switches and appurtenances used in an electric current.** Frederick Baumgart Nicholson and Edward Jennings Jennings, 7, Westminster-chambers, Victoria-street, London, S.W.

17,489. **Improvements in electric batteries.** Lucien Fouquo, 4, South-street, Finsbury, London.

DECEMBER 1.

17,511. **Improvements in insulators for supporting electric telegraph wires and the like.** Joshua Thomas Greenwood, 6, Lord-street, Liverpool.

17,535. **An improvement in, or addition to, electrically operated combination apparatus for domestic use.** Lionel Montagu Davis, 68, Fleet-street, London. (Complete specification.)

17,537. **Improvements in cells for secondary batteries.** Mark Bailey and John Warner, 21, Finsbury-pavement, London, E.C.

17,568. **Improved means in connection with multiple electric circuits for measuring current passing in either of them as desired.** Laurence, Paris, and Scott, Limited, and Reginald Laurence, 47, Lincoln's-inn-fields, London.

17,590. **Improvements in apparatus and devices for carrying and separating the plates of secondary batteries.** Henry Percy Holt, 70, Market-street, Manchester.

DECEMBER 3.

17,601. **Improvements in the construction and arrangement of electrical bells.** Henry William Handcock, 28, Martin's-lane, Cannon-street, London, E.C.

17,619. **Electrical measuring instrument.** Bernard Mervyn Drake and John Marshall Gorham, 2, Prince's-mansions, Victoria-street, S.W.

17,630. **Improved means and apparatus for effecting the successive bringing into action of two or more carbon pairs in electric arc lamps.** Sylvain Mathis and Etienne Boveroulle, 28, Southampton-buildings, London, W.C.

DECEMBER 4.

17,642. **An improved separator for the plates of primary and secondary galvanic batteries.** Joseph Moseley, 70, Market-street, Manchester.

17,645. **Improvements in electro-motors.** Stanley Charles Cuthbert Currie, 6, Livery-street, Birmingham. (Complete specification.)

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17,688. **Improvements in and connected with electric railways.** Sidney Howe Short, 55 and 56, Chancery-lane, London. (Complete specification.)

17,694. **Improvements in voltaic batteries.** Henry Inkson Harris and John Garford, 21, Cockspur-street, London, S.W.

DECEMBER 5.

17,718. **Improvements in electric cut-outs or circuit breakers.** Thomas Parker and Edmund Scott Gustave Rees, 70, Market-street, Manchester.

17,746. **Improvements in the manufacture of ceiling roses, switches, cut-outs, or other similar electrical fittings.** Wilson Henry Sturge, 12, Cherry-street, Birmingham.

17,765. **Improvements in electrical railway signals.** Walter Markby, 28, Southampton-buildings, Chancery-lane, London, W.C.

17,783. **Improvements in the manufacture of wire or tape from electro-deposited metal, for electrical or other purposes.** George Albert Sweetser, 65, Chapter-road, Walworth, Surrey.

DECEMBER 6.

17,795. **An improvement in electrical arc lamps.** James Brockie, 28, Southampton-buildings, Chancery-lane, London, W.C.

17,798. **Improved insulating apparatus for terminating or shackling and looping telegraph, telephone, and other electrical wires.** Andrew Smail Dunn, 62, St. Vincent-street, Glasgow.

17,848. **A new or improved code or system and table or chart, to be employed in transmitting and translating telegraphic messages.** Frederick William Burger, 57, Chancery-London, W.C.

17,850. **Improvements in electricmeters, or apparatus for measuring electricity.** William Richard Darlow Frost, 46, Lincoln's-inn-fields, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

DECEMBER 13, 1887.

17,138. **Improved apparatus for generating and converting electric currents.** Robert Henelade Courtenay, 1, Chatham-terrace, Battersea-park-road, Surrey.

DECEMBER 17, 1887.

17,415. **Improvements in electrical measuring and recording apparatus.** James Grieve Lorrian, Norfolk House, Victoria Embankment, London, W.C.

FEBRUARY 8, 1888.

1,875. **Improvements in dynamo-electric machines and in electro-motors.** George Hookham, 7 and 8, New Bartholomew-street, Birmingham, and Robert Holden Housman, Perry Hall, Bromsgrove, Worcestershire.

1,891. **A flexible battery cell and method of arranging the elements therefor.** Mark Bailey and John Warner, 21, Finsbury-pavement.

MACRH 3, 1888.

3,312. **An improvement in voltaic batteries.** Edward Tyer, 28, Southampton-buildings, Chancery-lane, London, W.C.

OCTOBER 18, 1888.

14,984. **Improved method of and apparatus for rotating hydro-extractors by means of a current of electricity and automatically checking or arresting the motion thereof when desired.** Richard Richardson Hutchinson, 4, Little Moorfields, London, E.C.

NOVEMBER 7, 1888.

16,146. **Improvements relating to electro-medical batteries.** Francis Moreton, Gray's inn-chambers, 20, High Holborn, London, W.C.

SPECIFICATIONS PUBLISHED.

1882.

1,769. **Secondary batteries.** J. H. Johnson. (Faure.) (Second edition.) 8d.

1,875. **Secondary batteries.** D. G. Fitzgerald and others. (Second edition.) 8d.

3,409. **Secondary batteries.** W. Taylor and F. King. (Second edition.) 4d.

3,812. **Secondary batteries.** J. S. Beeman and others. (Second edition.) 8d.

5,601. **Secondary batteries.** A. Tribe. (Second edition.) 6d.

1883.

1,122. **Secondary batteries.** D. G. Fitzgerald. (Second edition.) 8d.

1886.

14,983.* **Application of a selenoid for reinforcing electrical contacts.** E. W. Serrell. 6d.

1887.

2128.* **Printing instruments for telegraphs.** F. H. W. Higgins. 11d.

15,217. **Measuring alternating currents of electricity.** W. Lowrie and others. 8d.

16,790. **Dynamo-electric machines.** S. C. Hanberg. 6d.

16,807. **Incandescent electric lamps.** D. Urquhart. 8d.

17,582 **Indicating the time during which electricity is used for lighting, &c.** E. F. H. H. Luckert. 8d.

17,641. **Printing telegraphs.** J. E. Wright and J. Moore. 11d.

1888.

208. **Utilising waste products from electrical batteries.** O. C. D. Ross. 6d.

295. **Electric meter.** T. Parker and E. Rees. 8d.

302. **Electric meter.** T. Parker. 8d.

705. **Mouthpiece for telephone transmitter.** L. E. Percy. 8d.

1,016. **Electrical transforming apparatus.** A. M. Taylor. 4d.

2,259. **Thermo-electric and furnace batteries.** H. Mestern. 8d.

10,415. **Electrical dry elements.** C. Gassner. 4d.

12,754. **Electric bells, &c.** H. H. Lake. (Humans.) 1s. 3d.

13,035. **Socket electric lampholders, &c.** C. M. Dorman and R. A. Smith. 8d.

13,122. **Dynamo electric machines.** E. J. Paterson and F. C. Cooper. 6d.

14,522. **Galvanic batteries.** D. Humphreys. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	101
12 Feb.	1/2	Anglo-American Brush E.L.	4	4¼
12 Feb.	2/0	— fully paid	5	5¼
26 Oct.	7/6	Anglo-American	100	47
26 Oct.	15/0	— Pref.	100	69
12 Feb., 85	5/0	— Def.	100	15¾
14 Nov.	5/0	Brazilian Submarine	10	13¼
14 Nov.	0/4½	Con Telephone & Main	1	⅝
10 Aug.	9/0	Cuba	10	14½
10 Aug.	10/0	— 10% Pref.	10	19
12 Oct.	2/0	Direct Spanish	5	4½
12 Oct.	5/0	— 10% Pref.	5	10
26 Oct.	2/0	Direct United States	20	9½
12 Oct.	2/6	Eastern	10	12¼
12 Oct.	3/0	— 6% Pref.	10	15
1 Aug.	5%	— 5%, 1899	100	109
26 Oct.	4%	— 4% Deb. Stock	100	106
12 Oct.	2/6	Eastern Extension, Australasia & China	10	12¾
1 Aug.	6%	— 6% Deb., 1891	100	106
2 July	5%	— 5% Deb., 1900	100	106
2 Nov.	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	106
28 Mar.	8/3	German Union	10	9½
12 Oct.	1/0	Globe Telegraph Trust	10	6⅞
12 Oct.	3/0	— 6% Pref.	10	14½
30 April	5/0	Great Northern	10	14¾

Dividend.		Name.	Paid.	Price. Wednesday.
1 March	5%	Gt. Northern 5% Deb., '83.	100	106
27 July	10/0	India Rubber, G. P. & Tel.	10	17½
26 Oct.	12/6	Indo-European	25	40
14 Nov.	2/6	London Platino-Brazilian	10	8
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	½
26 April	4/0	Reuter's	8	7½
		Swan United	3½	2⅝
10 Aug.	13½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	40½
2 July	6/0	— 6%, 1889	100	105
29 Nov.	5/0	United Telephone	5	14
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	99
12 July	4/0	West Coast of America	10	9½
30 June	8%	— 8% Debs.	100	125
26 Oct.	6/0	Western and Brazilian	15	13½
26 Oct.	6/	— Preferred	7½	6½
11 May	2/1½	— Deferred	7½	6⅝
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	1¾
29 Nov.	12/0	— 6% 1st Pref.	10	11⅜
13 May, '80		— 6% 2nd Pref.	10	12
2 Nov.	7%	West Union of U.S.	$1,000	122
1 Mar.	6%	— 6% Sterling	100	104

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NOTES.

Long-Distance Telephony.—The long-distance telephone between Berne and Geneva is now open. The charge is 5d. for five minutes' conversation.

Central Station in Vienna.—A company has been formed at Vienna, with a capital of a million florins, for carrying out the projected central station at Mariahizf-strasse.

Lectures to Artisans.—We are informed that Prof. Fleming has been invited to give a second set of lectures before the workmen and pupils at Messrs. Crompton and Co., at Chelmsford.

Paris Bourse.—The Bourse, or Stock Exchange of Paris, will shortly be lighted with 2,500 incandescent lamps. The motive power for the dynamos will be furnished by compressed air motors.

Edinburgh Library.—The estimate of Mr. Richard Millar, St. Enoch's-square, Glasgow, for the installation of electric light at the Edinburgh Public Library, amounting to £1,795, has been accepted by the Public Library Committee.

Gassner's Dry Cell.—The use of Gassner's dry cell is making great progress in Germany. In the latest form hydrate ferric oxide is used as the depolariser. Ferric oxide is said to abandon all its oxygen in presence of sal ammoniac.

Branch Bank of England.—The Bank of England took possession of their new premises in Fleet-street, next the Law Courts, on Monday last. The premises are lighted throughout with electric light supplied by Messrs. Drake and Gorham.

Zurich.—The local authorities of Zurich have appointed a commission to study the question of the introduction of electric light into the town, for which water power to the extent of 750 h.p. is available, which might be used to feed 7,000 16-c.p. lamps.

Birmingham.—Messrs. Winfields, who have a cable from their works to the Birmingham Town Hall, now advertise that having put down additional plant and completed their new installation, they are prepared to supply light for hirers of the hall at reduced rates.

St. Martin-in-the-Fields Vestry.—The Vestry gave consent on December 13 to the granting of a license by the Board of Trade authorising the Metropolitan Electric Supply Company, Limited, to construct and maintain electric lines and works, and to supply electricity within the parish.

Electric Light in Woollen Mills.—A large firm of millowners, at Nelson, have adopted the electric light for lighting purposes, instead of gas. The new light enables the weavers to better detect defects in the cloth, as the lamps are so arranged as to throw a full light on the warps.

The Spanish Exhibition in London.—Definite arrangements have now been made, it is reported, for holding a Spanish Exhibition next year at Earl's Court, upon the site of the late Italian Exhibition, when the president will be the Duke of Wellington, Grandee of Spain, and the vice-president, Colonel G. T. North. It is anticipated by the authorities that the exhibition will be open to the public about the middle of April next.

Warming the Actresses.—The transformer at one of the theatres gets rather hot sometimes when full work is on. It has been suggested that a tube should be laid to the dressing-rooms from the transformer-room; this would serve both to get rid of the waste heat and warm the actresses.

Electric Execution.—The first execution by electricity will take place, under the new law, in the United States on January 9, to which day Governor Hill has respited Reitch, the wife murderer. The electricians are not yet agreed upon the strength of the shock necessary to kill the condemned man.

Malvern.—The Local Board of Malvern Link having had some trouble with their gas company, decided to light the public lamps with oil. The Board, however, are not entirely satisfied with oil, and have given instructions to the Lighting Committee to ascertain and report upon the probable cost of electric lighting.

St. Denis.—The Town Council of St. Denis, France, has authorised the laying of mains in the streets for distribution of electric light. The current will be supplied from a station which the company intend to construct at St. Ouen, and which will also supply a portion of Paris, for which a concession has been applied for.

M. S. and L. Steamer.—A new steamer, named the "Grimsby," was launched, on Saturday last, from the yard of Messrs. Earle's shipbuilding and engineering works, for the Manchester, Sheffield, and Lincolnshire Railway Company, for the ferry service between Hull and New Holland. The ship is built of steel, and will be lighted by electricity.

Ipswich.—The Town Council of Ipswich have given permission to run the wires overhead, such permission to be for twelve months only; the wires to be carried over any street at such height as the committee may in each case approve, the promoters undertaking in the meantime to take all necessary and proper steps to obtain a license or provisional order.

The Specialists' Series.—We understand that the long promised work on the telephone by Mr. W. H. Preece and Dr. Julius Maier will be published in a week or two by Messrs. Whittaker and Co. as a volume in their "Specialists' Series." A practical treatise "On Hydraulic Motors," by Mr. G. R. Bodmer, is also in the press as one of the same series.

Life Saving Telephone Service.—An example which might be imitated is that of Superintendent Kimball, of the New York Life Saving Service, who proposes to erect a telephone line next March on Long Island coast, from Coney Island to Montauk Point, a distance of 103 miles, with 30 stations, the work to be done by the corps. New Jersey is to be similarly equipped.

International Cable Convention.—According to the Berlin *Reichsanzeiger*, the British Government has announced the accession of various British colonies and possessions, including Canada, Newfoundland, the Cape, Natal, New South Wales, Tasmania, Western Australia, and New Zealand to the International Convention for the Protection of Submarine Cables. The convention was originally agreed to on March 14, 1884.

Charging Switch.—A switch has been invented which is a useful combination where sets of batteries have to be

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charged in parallel. Accumulators often vary in E.M.F. among themselves; the charging current will therefore vary in different sets. The switch has a resistance on each connection, and an ammeter which can be inserted in either circuit; the current through each set may be readily regulated to be of the same strength for each set of cells.

Electrician to the Dockyard.—The status of electrician is now being officially recognised. We are glad to see that in consequence of the importance which electricity has assumed in the fittings of the fleet, the Admiralty have appointed Mr. Lane, who has had charge of the electrical shops at Portsmouth without any distinctive position for a great number of years, to the new office of "electrician of the dockyard," with a substantial increase in pay.

Some Day, Some Day!—The Tesla motor, we hear on the authority of one who knows what he is talking about, really does go well, and is going to be a good thing. When—is the despairing cry of British electrical engineers—are we to have a real live Tesla motor sent over here? When are we to see it working? We have plenty of alternate currents for it to feed upon. And where, oh where! is to be the place where the little wonder to be procured?

A New Clutch.—Mr. E. Shaw, of Canons Marsh Iron Works, Bristol, has just perfected a new clutch, which should prove useful in electric light stations. It is finding favour in the milling world, and we recently saw a granary in which the main shafting was divided into four sections fitted with three clutches. These were controlled by steel tapes passing to the different floors, so that the various sections of shafting could be thrown in or out of gear from any floor of the building.

Extension of Telegraphic Service.—The Postal Telegraphic authorities are making arrangements for an important extension of the telegraphic communication between Glasgow and the North-West of England. From Glasgow the new line of wires will be carried along the Carlisle road until Beattock, in Dumfriesshire, is reached. The route will then be through central Annandale to Lochmaben, thence by Dalton to Annan, and across the Solway Firth to England. Several places at present without telegraphic communication will be accommodated.

Supply of Carbons.—The carbons for arc lighting in England at first were obtained almost solely from America, but for some time they have been largely imported from the Continent, and this source of supply is now probably by far the larger. The American carbons burn longer, but are not so regular; they often vary, flicker and give off sparks. The Continental carbons burn very quietly and steadily, but do not last so long. The difference is mainly due to the mixture of silica or other substances with the lampblack in the American manufacture, which are added to make the carbons last longer.

Indo-Persian Telegraphs.—Colonel Sir R. Murdoch Smith, director of the Museum of Science and Art in Edinburgh, has laid before the Royal Scottish Geographical Society a history of the Indo-Persian telegraphs, in the construction of which he played so important a part. He stated that 21 years ago, when the overland wire for Indo-European messages was proposed (which was completed in 1870), the expectation was that a message would eventually be got through in a period not exceeding three days! At present the time occupied by a message from the United Kingdom to any part of India, from handing-in to delivery, does not exceed an hour and a half.

City Lighting.—At the meeting of the City Commissioners of Sewers, on Tuesday, Mr. Bridgman said the Finance and Improvement Committee had done all they could in the matter of the electric lighting of the City. They had decided on the conditions of the tenders on which they had been advised by Colonel Heywood and Mr. Preece, F.R.S. As far as the committee were concerned, they were determined to have the matter settled before February. Mr. Rose-Innes asked whether it would be open to private persons or companies to tender. Mr. Bridgman replied that it would be publicly advertised, and the conditions would be sent to those who applied to tender.

The Inner Temple.—A petition to the treasurer and benchers of the Inner Temple is being extensively signed by the members of that Inn against the extensive works at present in progress, in the Inner Temple-gardens, in connection with the installation of the electric light in the Inner Temple. The petitioners point out, among other things, that the erection of the engines, dynamos, and works in the Inner Temple-gardens will not only seriously depreciate the value of the chambers in the vicinity, but will constitute a permanent eyesore and disfigurement to the gardens. The petitioners therefore pray that if the extension of the electric light in the Inner Temple cannot be carried out except at such a sacrifice, the scheme be forthwith abandoned.

Telegraphic Communication Across the Channel.—Sir G. Campbell, in the House of Commons, on Monday, asked the Chancellor of the Exchequer whether he could give the House an assurance that any cables or plant taken over from the company which had had for a long term a monopoly of telegraphic communication across the Channel would not be taken at a price exceeding the actual present material value, and that the community using the Government cable in future would not be subjected to charges due to an excessive price paid as any sort of indirect compensation to the company for the loss of a monopoly so long enjoyed. The Chancellor of the Exchequer said that it would be impossible to make any definite and full statement to the House on this subject until the termination of the negotiations now in progress. The interests of the public will be safeguarded in every possible manner, and he hoped that he should soon be in a position to make a satisfactory statement to the House upon this question.

Electric Treatment of Sewage.—The Electrical Purification System, Limited, which is carrying out Mr. Webster's system of treatment of sewage—and of which Mr. Webster is practically the heart and soul—has offices in Trafalgar square, and is expecting to do great things as a result of the large experimental trial which has been carried on at Crossness. The Metropolitan Board of Works granted land at a point where the sewage issues from the main sewer, and buildings and machinery were erected by Mr. Webster at his own expense. A 40 h.p. engine is used to drive a special Edison-Hopkinson dynamo, and we understand that early next month the Press and those specially interested will be invited to see a practical demonstration of the system. The sewage is treated electrolytically; the organic matter rises to the top in the form of a thick sludge; and the clear effluent water is drawn off from below. We trust Mr. Webster will work out authoritative details of the cost of his new system, such as can be placed before local authorities who are contemplating the perfecting of their sewage systems.

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Wrought Metal Flower Pendants.—We have been shown a number of very beautifully-wrought designs, made by trained industrial schoolboys, in exact imitation of natural flowers and foliage, which are being taken up by Messrs. Laing, Wharton, and Down, and may be shortly seen in their showrooms in New Bond-street. These are hammered and curled in thin sheet metal—brass, copper, bronze and zinc—in lovely sprays of passion flower, rose and vine, and have been adapted for use in fittings and pendants for electric light. The beauty of the incandescent globe has induced corresponding development in the beauty of the fittings, and none are more decoratively suitable than natural floral ornament. These metal flowers are not welded or soldered in the ordinary way, but are rivetted or wired together, each leaf and petal being hammered separately, copied from nature, and the whole making a perfect piece, woven together into a spray. Fittings of this kind have usually to be imported from Italy, France, or Germany, and we are sincerely glad to see the growth in this way of small artistic industries in England for this class of metal work, beautiful in appearance and not too dear in price.

The Electric Light at Cannock Chase.—At the bi-monthly meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers, Mr. Arthur Sopwith, M.I.C.E., read a paper on "Electric Lighting at the Cannock Chase Collieries." He fully described the system, exhibited lamps and copper cables used in lighting the collieries, and compared the cost of electric lighting with gas in favour of the former. Mr. Sopwith also described an effective method by which the cables were protected by being enclosed in rough boxes and protected inside the boxes by coaldust and tar. The only novelty at the Chase was that old iron ropes had been used for the purposes of economy in the installation on the surface. The shops, village church, schools, and houses were lighted by electricity, and there were 80 lights in No. 3 pit. A long and interesting discussion followed, and the president (Mr. David Peacock) spoke of the paper as a most excellent one, free from too much science, and laying before the meeting a positive and valuable accomplished fact. A hearty vote of thanks was given to Mr. Sopwith, and it was agreed to have the paper printed for further discussion.

Automatic Delivery Boxes.—A meeting was held on Wednesday, at Cannon-street Hotel, of the shareholders of the Electric Automatic Box Company. One of the boxes was on view, and a report was read from Mr. Ingrey, patentee, manufacturer, and proprietor of a large automatic box business. In this he said that the boxes were of two kinds, the smaller one for pennies only—this had no distinct advantage over the mechanical automatic boxes; the larger was for threepenny articles, and for this Mr. Villiers Stead's invention was most ingenious and effective, the use of electricity being absolutely necessary. It can be worked by a threepenny piece, or by any combination of coins representing the total value of 3d.—thus, two pennies and two halfpennies, six halfpennies, one penny and four halfpennies, two pennies, one halfpenny, and two farthings, etc. He had very carefully examined and tested this machine, and gave it as his opinion that it has been very cleverly thought out, and is certainly effective. Some points of construction will require to be modified; for instance, the large machine is very much too heavy. It was proposed to try the scheme for a year, and the shareholders decided to appoint a committee to confer with the directors, and to carry on the invention.

Houses of Parliament.—On Monday last, in the House of Commons, Mr. Howorth asked the First Commissioner of Works whether, during the ensuing recess, he could see his way to make such an extension of the electric lighting arrangements in the House as would check further injury to the stonework in the corridors and staircase leading from the Star Court to the Commons lobby; and whether it would be possible to carry the electric light into the different rooms connected with the reporter's gallery? Mr. Plunket: I quite agree in the desirability of the objects sought by hon. friend, and I have under consideration a scheme for extending the electrical lighting of this building, which would include and go somewhat further than the suggestion of my hon. friend; but the cost of the installation would be considerable, and I must obtain the opinion of the Treasury upon its financial aspect. I fear it would not in any case be possible to complete the arrangements earlier than Easter. Sir J. Swinburne enquiredwhether the right hon. gentleman was aware that the electric light had been so dim in the library that members had had to use candles as auxiliaries. Mr. Plunket thought it must be very seldom that candles were used. He had never seen them in the library.

New Electric Lighting Building in Philadelphia.—The Edison Electric Light Company, of Philadelphia, says the *Scientific American*, has its new central station under roof and the machinery is being put in. The building is put up for solidity and strength rather than for appearance or decoration. It is six stories high. On the first floor will be placed 20 engines of 250 h.p. each. On the second floor there will forty dynamos, with a total capacity of 60,000 lights. The third floor will be used for the workshop. The fourth floor for 10 boilers of 500 h.p. each. The fifth floor will accommodate 1,000 tons of coal, which will be fed by pipes to the furnace under each boiler. The sixth floor will be devoted to the general offices of the company, and will be fitted up in a very elaborate manner. The company has already about 28 miles of electrical conductor underground. Its underground system is through metallic tubes, with three copper wires, which are insulated by composition. The tubes have junction boxes at every 20 feet. It has 84 miles of copper wire underground. It considers the station well located, as it is in the geographical centre of the district. Already 9,000 lamps are engaged, and expect to have 10,000 when they start up, which will be about the middle of December. The station when completed will be the finest in the world. All the large new buildings for banking institutions and trust companies will be lighted by this company, and the new Bulitt building will have 2,100 lamps. The company will also furnish power for motors, and will not discriminate between any motors for which it serves power. This is one of the finest electrical buildings ever erected in the United States. It cost 150,000dols. The total investment, including wires, will be 1,000,000dols. It will be ready for operation inside of a month—at least, this is the present anticipation.

Maximum Gradients on Electric Railways.—With reference to the maximum gradients on electric railways, the general manager of the Thomson-Houston Electric Company gives the following result of the extensive experience and practice of that company in the *American Engineering News*: Concerning gradients, we should say we can operate a car up very steep inclines, provided that if traction cannot be obtained a suitable rack and pinion be used. In Allegheny city, for instance,

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gradients of over 12 per cent. are ascended by cars equipped with our 15 h.p. motors. In this instance, as it was deemed unwise to depend entirely upon adhesion between wheels and rails, a special form of rack was attached to the side of the rail, and one pair of wheels was provided with projections around its periphery, serving as teeth. By this means still heavier grades could be ascended, and the question would then resolve itself into one of power. In Pittsburg there is also another line where gradients of 15 per cent. and over are ascended, but in this case there is a rack in the centre of the track and a special toothed-wheel is attached to the motor. There is no reason why a 20 per cent. gradient could not be ascended with such necessary adjuncts, as on the Mount Washington road. We look upon it as purely a mechanical problem. Dependent upon adhesion alone, however, we would state that the portion of the Lynn and Boston tracks in Lynn, Mass., equipped by us, is an illustration of as heavy a gradient as we have yet ascended. We think, however, that 12 per cent. is as high as should be gone under the circumstances. In this case, also, we have taken the added precaution of placing on the track extremely powerful track brakes; these act as an adjunct to the required wheel brakes. A 10 per cent. grade is easily ascended, and we have a number of roads in operation to-day that have such grades.

Leamington.—The monthly meeting of the Leamington Town Council was held on Monday. A report was received from the Watch Committee relative to the electric lighting system, stating that they considered the time had arrived when some decision shou'd be arrived at with reference to the various systems now on trial. Alderman Gibbert said the public were anxious that the matter should now be settled. The continued flickering of the lights on the Parade quite justified them in pressing the electric lighting company for decision. The four arc lights in the Parade were very good when they were alight, but they were continually popping in and out. Mr. Fell said he had seen the representatives of the company, and he hoped they would submit a report without delay. Mr. Crowther Davies said when it was proposed to put four arc lights in front of the Town Hall, the assurance was given that it should be a good arc light. Well, they had seen the results, and they all knew what they were. There was always one out, often there were two, sometimes there were three, and on occasions they had all been out. He felt certain that the public would never have the arc system. Then there was what was known as the sunbeam system. That was a light which was good, but it was estimated that the cost of lighting the Parade with it would be £600 per annum. Then there was the present electric light, which was the incandescent red-hot wire, which they were told would attract visitors to Leamington, but which, in fact, would not attract a moth. Dr. Thursfield condemned the present arc lights, but he said he had seen some very good arc lights in other towns. Alderman Wackrill also admitted that the arc lights were not satisfactory. The report was adopted; and it was agreed that a meeting of the General Purposes Committee should be held at an early date for the purpose of discussing the question, after the electric lighting company shall have submitted the cost of the several systems now before the town.

Cowpen.—The following is the text of the tender of Messrs. Nicholson and Jennings with regard to the lighting of Cowpen, which was unanimously recommended for adoption at a special meeting of the Board on Friday last, and a draft agreement ordered to be prepared: "We undertake to supply you, for a period of five years, with 18 arc lamps of nominal 2,000 c.p., at a yearly rental of £575 (five hundred and seventy-five pounds), we to light the lamps from the 15th of August to the 15th of May in each year, with the exception of four nights in each month at the time of full moon, when no lights are required. The rental of £575 to be paid as follows: 1st November, £190; 1st February, £195; and on the 1st May, £190. We to allow the Board a discount of five per cent. on the amount received by us from private consumers—the amount of such discount to be ascertained and a statement submitted to the Board. We to supply all necessary plant for running the above lights, and erecting the building for containing the same, you providing the site, we paying you a nominal rental. It is also understood that you render us any assistance we may require in the way of helping us to obtain permission to attach our wires to houses, etc., etc. You to have the power of purchase at any time by giving three months' notice to us at our London office, on the following terms: During first year for sum of £1,122; during second year for sum of £1,010; during third year for sum of £901; during fourth year for sum of £818; during fifth year for sum of £736. Such three months' notice to be given on the 1st October in any year, so that the plant would be taken over on the first day on the following year. Schedule of plant included in the above sum will be submitted with agreement, such sum as mentioned above not to include any plant we may put in for the purpose of private lighting; and if you desired to purchase this, then you to have power do so on terms to be agreed between us. Failing such agreement, then the matter to be decided by arbitration in the usual manner. The contract may be renewed by mutual consent. We undertaking all responsibility under the Electric Lighting Acts of the Board of Trade Regulations in all matters concerning this contract."

Kensington Vestry.—The Special Committee for Electric Lighting reported that they have considered the letter from the Chelsea Electricity Supply Co., Limited, asking for a way-leave for an electric main in Ovington-gardens, Brompton-road, for the purpose of connecting certain mains of the company, and reporting that the committee are not prepared to advise the Vestry to accede to such application, and the Board of Trade have stated that they do not propose to entertain any further applications from electric lighting companies for licenses in respect of such areas in the metropolis. A deputation, consisting of Mr. Alexander S. Hill, Q.C., M.P., Sir Theodore C. Hope, and Mr. Charles Fish, attended the committee on behalf of inhabitants in the vicinity of Queen's-gate, urging that permission should be granted to the Kensington Court Electric Lighting Company for the extension of their mains, and referring to the inconvenience by the delay in granting licenses for the supply. The committee recommended that in the event of application being made by the Kensington Court Electric Lighting Company, Limited, to the Board of Trade for a license under the Electric Lighting Act, 1882, to lay down wires for the supply of electricity in streets in the vicinity of Queen's-gate, the Vestry do give their consent to such application so far as regards the undermentioned area, subject, however, to conditions being agreed

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to by the company similar to those contained in the license above referred to, and provided that, in the event of any general system being hereafter adopted by the Vestry for the laying of mains, etc., the company undertake to change the mains now proposed to be laid in such manner as to conform to and generally to be subject to such future system. All the mains, etc., now proposed to be laid down, to be laid in such part of the roadway or footway, and generally on such conditions and in such mode as may be approved by the Vestry's surveyor. Mr. Holmes thought that if the demands of the deputation with reference to the granting of licenses to that particular company in that portion of the parish were acceded to, it would create a monopoly for that company. He moved that the matter be referred back. Mr. Duffield (chairman of Works Committee) hoped that the recommendation of the committee would be supported. Mr. Bray seconded Mr. Holmes's motion, while Mr. Lindsay also supported the recommendation of the committee, which was finally carried.

City Guilds. — The prizes and certificates gained by the students of the City Guilds Institute were distributed on Wednesday at the Fishmongers' Hall by Sir Lyon Playfair, M.P. The Lord Mayor presided, supported by Sir F. Bramwell, Sir F. A. Abel, Sir Owen Roberts, Sir Philip Magnus, Sir J. C. Lawrence (Prime Warden of the Fishmongers' Company), the Rev. J. R. Diggle, Professor G. G. Stokes, M.P., Professor Sylvanus P. Thompson, Professor W. C. Unwin, and others. Sir Lyon Playfair alluded to the original position of the guilds as a university of smiths, or tailors, or carpenters, with the same object and with the same right to use it, as to the Universities of Oxford and Cambridge. In alluding to the position of the workman, machinery, he said, had brought about a great subdivision of labour, by which the workman was relegated to one small corner of his industry, and did not know the whole mystery of his craft, as he did in the old days. Until recently, until the City and Guilds Institute and other promoters of technical education arose, he had no means of dignifying his labour by understanding the whole field of the industry in which he was engaged. The ignorant workman woke one morning and found that a new machine had been invented which dispensed with his labour. He had learnt to do nothing else, and he was added to the large army of the unemployed, not having had the education to adapt himself to the dislocations of labour which were happening every day. The City and Guilds Institute had been formed to give men the opportunity of acquiring knowledge which would enable them to adapt themselves to the new order of things when such dislocations occurred. The competition of the world was becoming a competition of intellect, and if in any one branch we fell below that of a foreign country we should be beaten. The success of nations in the future would depend on the trained intelligence—or, in other words, the technical education—of their working men. The guilds had recognised the necessity of adapting themselves to the industrial progress of the world; and had shown their readiness to promote the industries which they were founded to promote. He considered that the country owed a great debt of gratitude to the City and Guilds Institute, which had set a noble example to the whole kingdom.

General Electric Catalogue.—We have received an advanced proof from the General Electric Company (Messrs. Binswanger), 5, Great St. Thomas Apostle, E.C., of the new issue of their catalogue of electrical supplies. This, the fourth edition of their catalogue, is extremely comprehensive, ranging from one end of the electrical supply scale to the other, and including almost every electrical requirement for the completion of installations. The items are carefully arranged and described, and we note the arrangement by which every article can be referred to by its reference number only, from 1 to 7,020. It is evidence not only of the great development of electrical industries, but of the continual activity and enterprise of Messrs. Binswanger, who have now worked themselves into the front rank of supply companies, and now supply and for the most part keep in stock a very complete supply of all kinds of articles of requirement for electrical engineers. Every department is fully illustrated, reference numbers in all cases being appended. We note several good arrangements of main switchboards, for accumulator installations, for coupling dynamos, and for distribution in theatres and large buildings, which are supplied ready made up. Main switches of several substantial varieties appear, and the number of makes and designs of small single-light switches from the cheapest kind, to ornamental and cut glass, is sufficient to choose from for all kinds of installation work. We notice one very neat little double-pole switch, in which contact is made by a solid piece pressing apart the two poles at each side of the switch-base, a neat and satisfactory form. China bases play an important part, many of these being artistically decorated. China sockets, lampholders of all classes, and cut-outs of great variety, of course, find a full place. A new cut-out, in which the fuses, with slotted end plates, are made to screw into position from the side, is a new introduction. The General Electric Company are agents for Edison-Swan lamps, the Victoria, and Woodhouse and Rawson (unflashed) lamps, and high c.p. sunbeam lamps, also all usual requirements in wire and cables, and all these are kept in stock. A special feature is made with Dr. Aron's electricity meter, and Schuckert's ampere and volt meters; the Kohlrausch ammeter for small installation is a very cheap instrument. One of the features of the catalogue—a point to which the General Electric have always directed their attention—is the large variety of glass ware, shades, pendants, and screens for electric lamps, and some 12 pages are devoted to illustrating their designs of fancy shades. Arc lamps and fittings come in for their share, and the "Apostle" carbons, soft-cored (for which there is no extra charge in this list), are kept in a large number of various sizes for arc lamps. We note that the company now supply a speciality of their own in dynamos, which they name the "Britannia," an eight-pole drum armature machine, used for arc and incandescent lighting, depositing, and plating purposes, and made also for alternating currents, with transformers. Experimental dynamos for laboratory work are shown, and the Reckenzaun motor for power purposes. We should imagine a small cheap motor will now be worth pushing by this firm for use on central station circuits. Casing, cleats, jointing materials, asbestos, insulators, etc., and special tools for electricians are all included, and for domestic use sundry articles are illustrated, which we expect may soon form an extensive class of novelties by themselves—namely, electric saucepans, coffee-pots for boiling water, electric water-heaters, electric curling-iron heaters, electric cigar lighters, etc., easily adapted to houses having a supply of current. An index and guide to electrical terms, not too severely scientific, complete the catalogue, which we may add is issued uniformly with their sixth edition of electric bell work, and can be bound together with this.

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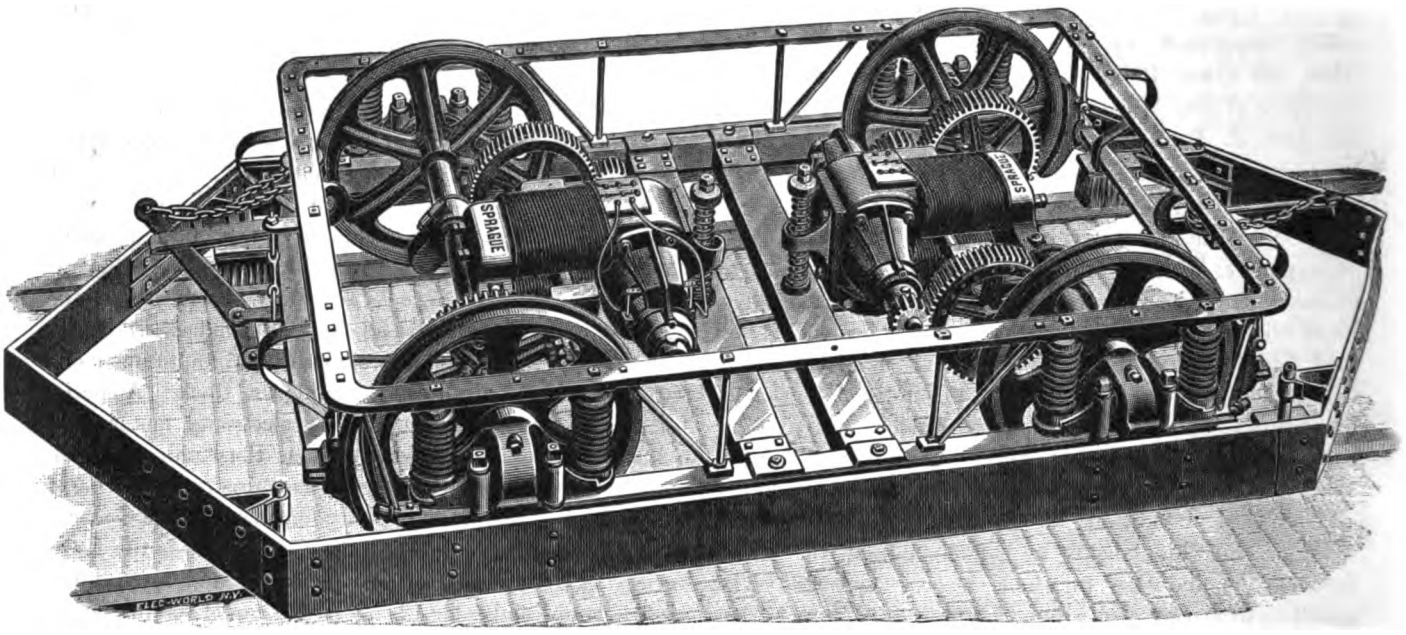
THE NEW SPRAGUE MOTOR.

The extended use of electric motors in America for tram work causes manufacturers to carefully examine the mechanical and electrical modifications that can be introduced, in order to obtain the best results. The illustration given herewith shows the latest arrangement adopted by the Sprague Electric Railway and Motor Company of New York.

The motor is built in two sizes, of 7½ and 15 h.p. capacity, which are identical in general appearance. The truck shown carries two motors of 15 h.p. capacity They are adapted to be applied either to standard cars or to special truck. They have the regular Sprague mounting, being centred on the axles and flexibly suspended. They are very compact and powerful, and embody the most recent improvements to meet the exigencies of street car service. The armature pinion meshes into an intermediate with vulcanised fibre teeth to ensure quiet running, and the pinion of this shaft into the main gear. All bearings are self-oiling, dust proof, and independently removable. Everything is designed for great strength and ready replacement. The brushes are remarkable for ease of adjustment, and are made on a new principle. Each brush consists of a number of flat, square, copper strips, fastened loosely in a holder by a pin passing through the centre. The strips set themselves in the direction of rotation, and the surface of the brush contact conforms to the curve of the commutator.

A tight-fitting cover, moving with the machine and enclosing the gears as well, may be attached. Both the armature bearings, which are self-centreing, and the intermediates, are fitted with oil and dust guards.

The evident design is to not only make the machine very strong and readily accessible, but to reduce the attendance to a minimum. The name given to this motor is the "Boston."



The New Sprague Motor for Tramcars.

A FEW SUGGESTIONS.

We must admit the hard impeachment that in at least one respect the Americans are our superiors. They possess more speculative enterprise, and more—to use a trans-Atlantic expression—goaheadedness than us. Where our operations are governed by the so-called conservatism of Englishmen—that is to say, by adherence to Old World traditions—Cousin Jonathan studies the wants of new markets and adapts his wares to them, instead of losing prestige in the effort to force articles that have been found good enough for others upon them. We do not mean to say that such is the case with electric lighting companies, that they lack in the energy and the ability to find outlets for their manufactures, and to obtain results which, in point of success, would not recommend themselves to the most fastidious; but we should like to record our opinion that commercial men in general and the promoters of the electric light amongst them might, perhaps, if they exhibited more patience and less off-handed contempt for things foreign, do a greater volume of business.

As an instance of our meaning, it naturally suggests itself that if the electric light can make, as it has made, headway in a country where artificial light of good quality is furnished at a merely nominal cost, the exploitation of it should be profitable in other countries where great difficulties and great expense attend the use of even the most ordinary illuminants.

To mention one of many places, St. Paul de Loanda, on the South-West Coast of Africa, a city which is to Portugal as Capetown is to England, would, we are sure, gladly welcome and subsidise any scheme, electric or otherwise, which would be free from the objections attaching to petroleum lighting in a tropical climate.

The population of Loanda, according to the last census, is 13,576, of which about 5,000 are whites. The houses of business and shops in the lower and more concentrated portion of the town are not inferior in number to 150, many of them burning 10 and 12 lamps between the hours of 6 and 10 p.m. The town itself is lighted by 350 lamps of the Hink's pattern, burning approximately 1,500 hours per annum, at a cost of £1,500. An additional sum of £1,100 or £1,200 is spent by the Government on the lighting of the public departments, the hospital, etc., and in a short time the railway authorities will have to extend their outlay in this direction.

As may be imagined, the quality of the light is very poor—poor for two reasons: the petroleum is usually inferior stuff "jobbed" by an interested town councillor, and, native attendants being employed, the wicks are seldom well trimmed or the lamps properly cleaned. In fact, it may be laid down as an essential condition that any system of illumination dependent for its efficient maintenance upon the industry and intelligence of native labour cannot give satisfaction.

The calculated cost of lighting as it is at present carried out in Loanda contains some interesting figures. Taking the commercial centre, we find that in a radius of 300 yards there are an average of 600 lamps in private use, costing £3,600 a year, without attendance, and 100 street lamps at £428, making a total of £4,028 per annum.

We understand that the Camara Municipal of this city are willing to guarantee eight cantos of reis, or £1,776, per year rental for 400 lamps of 16 c.p., and are furthermore assured that should central station lighting be introduced there it would be safe to reckon upon a subscription of 600 16-c.p. lamps at £6 each per annum.

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Besides Loanda, there are other towns, such as Dondo, Benguella, Mossamedes, and St. Thomé, at which small installations on the central station plan should pay good dividends.

Another matter of considerable importance in connection with this part of Africa, and a matter which we think worthy the very serious attention of those interested in telpherage, is the question of the transport of native produce, such as coffee, ivory, and rubber. As may be known, the rich districts are nearly all interior, and except where water carriage is available (averaging in price 2d. per ton per kilometre) the traders are entirely dependent upon the native porters, who, be it remarked, not only charge rates varying from 2s. 6d. to 13s. per ton per mile, but very frequently refuse for months together to do any work at all. The consequence has been ruin to many, serious loss and inconvenience to all. At one place the native salesmen will only dispose of their produce for salt, and if that is not procurable, will take their trade to another settlement, or perhaps destroy or abandon the greater part of it. Now, salt is a very perishable article, and it sometimes happens, when it is conveyed inland by native porters, that a rainstorm comes on, and the salt is distributed along the line of route in the form of brine. This, and other considerations of a like nature, would, we imagine, induce the traders and the powers governing these settlements to encourage any reasonable proposal which would have the effect of assisting in the development of the country. Railways are expensive, and unless viewed as creative influences, are not as yet required in the majority of the districts we are discussing. With a large supply of fine timber, and in several instances waterfalls to be utilised for power, a telpher line would present a means of transport at once economical and quite adequate to the requirements of the place. Its advantages in a country like Africa, where the passenger traffic can be practically disregarded, are manifest. Its erection is simple, not requiring much labour, and can be carried out rapidly. The nature of the country is of small moment, and the cost is from one-fifth to one-tenth that of a line of railway. We are not connected in any way with telpherage, and simply mention it as a system of transport that has been brought before the public, and with which we are acquainted. Any other method, mechanical or electrical, doing the same amount of work with the same amount of attention and at the same cost, would answer the purpose equally well. There is a good deal of money in this and in other projects which suggest themselves at times to the globe-trotter. The difference between us and our American cousins is simply that they are larger in their ideas, readier to calculate chances, and less timorous of risks. The ventures of this kind which they have taken up and turned to profitable account are numerous. Africa, or tropical Africa, however, has been comparatively untouched by them, their solitary adventure in Liberia not having turned out a success. It rests now with our English capitalists whether they will take advantage of their opportunities or not.

ELECTRIC LIGHTING OF THEATRES.—I.

We have long been of opinion that the lighting of theatres throughout by electricity should be made compulsory, as it is in Paris, Milan, Madrid, and other Continental cities, on account of the safety from fire ensured—if proper precautions are taken—to those before and behind the proscenium wall. We purpose now giving a short series of articles upon the use of electricity in London theatres for general lighting, and also for scenic effects; and we think that at this period of the year, especially devoted to festivities and amusements, the subject of the articles will be thought seasonable. As our readers are no doubt well aware, a large number of important London theatres are now wholly or partially lighted by electricity, and we hope that the putting on record of the general satisfaction expressed by the managements of those theatres which have already adopted the electric light, will have some influence in inducing the theatres still lighted by gas to discard that illuminant in favour of its rival, electricity. At the same time, by bringing to the notice of electrical engineers any objections that may have been felt in these early theatre installations, we hope to render still more perfect systems of lighting in theatres yet to be fitted electrically.

The question of lighting theatres differs in its most essential point from that of mills or factories in that whereas in the latter the item of expense is perhaps the chief consideration in its adoption, in theatres by far the chief point is the element of safety. In places of public amusement also, where the buildings, the decorations, and all accessories are made beautiful and luxurious almost regardless of expense, the additional luxury of a pure and safe light is one to be obtained even at increased cost, if need be; but we are pleased to find that in many cases no such extra expense has been incurred. We shall endeavour, wherever possible, to obtain data or some expression of opinion upon this point from the managers of the various theatres, with a view of showing, as far as possible, the reasons which lead to increase or diminution of expenditure for lighting, and the means adopted by the various electrical engineers to obtain the greatest effect in theatres with the minimum amount of outlay.

The increase in comfort and healthiness for the audience are matters which at once commend themselves to the public, and it is not necessary to point out the very great advantages to all concerned in this respect. The advantage to the actors is a point to which some attention may be given, and also to that of the comparative value of lighting behind and before the stage. From the health and comfort point of view, the lighting of the theatre before the stage by electric light may be commendable, but when, as is the case in some theatres, gas still obtains behind the scenes, the whole value from a safety point of view disappears. It would be clearly better to reverse the proceeding, giving the stage first the electric light and extending the advantage to the audience afterwards, if the whole installation could not be undertaken at once.

One incidental advantage which has been mentioned at an important theatre is that the use of electricity for the footlights prevents the ascent of streams of heated air, which with gas often gave a wavy appearance to the objects and persons in the stage and was very objectionable and irritating to occupants of the stalls.

In the matter of insurance, some important items came out on investigation. In some theatres the management obtain a considerable reduction in their rate of insurance—as much, in one case at least, as 25 per cent. in the premium on account of the introduction of electric lighting. Other theatres not being electrically lighted, do not obtain such a reduction.

The absence of dust, dirt, and heat in the electric light has already had its effect in inducing greater outlay for lovely and costly decoration in enhancing the beauty of the theatre in more than one case. The new Burg Theatre at Vienna is an important example, where really costly pictures and tapestry form one of the chief features of the decoration of the theatre. The recently-opened Lyric Theatre is most artistically and delicately beautified, and proprietors of theatres will feel more justified in decorating their houses in a manner which shall afford a real and lasting pleasure when they are assured that the expense they have gone to for such decoration shall not be lost in a short year or so by the deposition of dirt and from the heat of the gas-lustres.

In a position such as a theatre, where every item of trouble is of importance in the interior organisation, the greater ease of lighting up, of management of the light, and absence of cleaning, is a point of advantage. It may be interesting to consider in this connection the arrangement, now the practice in many cases in French theatres, of the electric company or contractor taking the whole responsibility of running the installation—supplying current, men, and renewals, and generally undertaking the whole control of the light, under the direction of the management, instead of the service stopping at the main, as is almost always the case with gas.

The advantage in the control of the light is greatly in favour of electricity over gas even for ordinary lighting in the footlights and battens. Arc lamps, in some cases, are employed to replace the lime lights, and small fairy lights

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have been used by the dancers. Besides these, in many cases special scenic effects are produced, and wherever this is the case we shall endeavour to describe how these are obtained, and what arrangements or special apparatus are adopted.

MAGNETISATION OF IRON.

Continuing their researches in this direction, Prof. Ewing, F.R.S., and Mr. W. Low have contributed a paper to the Royal Society "On the Magnetisation of Iron and other Magnetic Metals in Very Strong Fields," of which the following abstract appears in *Nature*:

"The large magnet of the Edinburgh University, kindly lent by Prof. Tait, was used throughout the experiments, and allowed the authors to effect a high concentration of the magnetic force by using bobbins, the necks of which had a cross-sectional area of (in some cases) only $\frac{1}{1500}$ of the cross-sectional area of the magnet cores. By this means the induction $\mathfrak{B}$ was raised to the following extreme values:

	C.G.S.
In wrought iron	45,350
„ cast iron	31,760
„ Bessemer steel	39,880
„ Vickers' tool steel	35,820
„ Hadfield's manganese steel	14,790
„ nickel	21,070
„ cobalt	30,210

The induction was measured by means of a coil consisting of a single layer of very fine wire wound upon the central neck of the bobbin. Outside of this coil, at a definite distance from it, a second coil was wound, and the magnetic force was determined in the annular space between the two. In a paper communicated to the Manchester meeting of the British Association, the authors showed that if the force so measured could be proved to have the same value as the magnetic force within the metal neck itself, it would follow that the intensity of magnetism $\mathfrak{J}$ had begun to diminish under the action of excessively strong fields, in the manner which Maxwell's extension of the Weber-Ampère theory of molecular magnets anticipates. In the present paper the authors discuss at some length the question of how far the magnetic force within the metal is fairly measurable by the magnetic force in the ring of surrounding air, and they show that, with the form of cones originally used, the force within the metal must have been less than the force outside by an amount probably sufficient to explain the apparent decrease of $\mathfrak{J}$. The form of cone suited to give a uniform field of force with sensibly the same value in the metal neck and round it is investigated; and experiments are described in which the condition necessary for a uniform field was satisfied. The results of these experiments are conclusive in showing that no considerable change takes place in the value of $\mathfrak{J}$ (in wrought iron) when the magnetic force is varied from about 2,000 to 20,000 C.G.S. units. Throughout this range of force, the intensity of magnetism has a sensibly constant value of about 1,700 C.G.S. units, which is to be accepted as the saturation value for wrought iron. The term saturation may be properly applied in speaking of the intensity of magnetism, but there appears to be no limit to the degree to which the magnetic induction may be raised.

The following are probable values of the intensity of magnetism when saturation is reached in the particular metals examined:

	Saturation value of $\mathfrak{J}$.
Wrought iron	1,700
Cast iron	1,240
Nickel (with 0·75 per cent. of iron)	515
Nickel (with 0·56 per cent. of iron)	400
Cobalt (with 1·66 per cent. of iron)	1,300

Experiments were also made with specimens of Vickers's tool steel, and other crucible steels, Whitworth's fluid-compressed steel, Bessemer steel, Siemens steel, and Hadfield's manganese steel. This last material, which is noted for its extraordinary impermeability to magnetic induction was found to have a constant permeability of about 1·4 throughout the range of forces applied to it—namely, from 2,000 to nearly 10,000 C.G.S.

ON THE DETERIORATION OF LEAD SHEATHING ON CABLES LAID IN CREOSOTED WOODEN CONDUITS.

BY ROBERT H. ENGLE.

Among the many conduits devised, none appear so antagonistic to lead encased cables as those constructed of creosoted wood. Ordinarily they are constructed in sections of about 20ft. each, and divided into numerous rectangular compartments, each of which is designed as a receptacle for a cable, which is pulled through by a rope from manhole to manhole, usually the distance of a square apart. Owing to the friction of the wood on the lead encasing in drawing it through, these compartments must of necessity be much larger than the diameter of the cable, and, in consequence, form a reservoir for the accumulation of vapours and gases. In a very short time a chemical action takes place between the wood of which the conduits are made and the crude creosote with which they are saturated, or kyanized, and there is set free acetic acid and carbonic acid gas. The reaction of these two chemical agents upon the lead may be expressed by the following equations:

$$Pb + 2C_2H_4O_2 = C_4H_6PbO_4 + 2H.$$
$$C_4H_6PbO_4 + 2H + CO_2 = PbCO_3 + C_2H_4O_2 + C_2H_4 + O.$$

To express the reaction in words to those who may be uninitiated in chemical nomenclature: The first member of the first equation, lead (Pb), combines with the acetic acid ($C_2H_4O_2$) formed from the action of creosote on wood; the second member to form acetate of lead ($C_4H_6PbO_4$) and hydrogen (H). In the second equation, lead acetate plus hydrogen plus carbonic acid gas (CO_2) set free in the conduit during the formation of acetic acid, unite to form carbonate of lead ($PbCO_3$), acetic acid, olefiant (C_2H_4) and oxygen (O) gas.

The acetic acid acts upon the lead, converting its surface into a film of acetate of lead, which, as soon as formed, is acted upon by the free carbonic acid gas, converting it into carbonate of lead, releasing free acetic acid, which attacks the next layer of lead below the one already acted upon, and so on, until the entire sheathing is converted into carbonate or white lead. These creosoted conduits are, therefore, practically underground white lead factories on an extended scale—"electrical conduits" seems to be a misnomer for them. Many have been the devices and suggestions to allay this chemical action, but no one seems to have arrived at anything that is at once economical, effective, and practical. Some suggest that a sheathing be made of an alloy of lead and tin that would effectually resist the chemical action going on. This would require an alloy holding a heavy percentage of tin, and while it might be effective it would neither be economical nor practical; not economical for the reason that the first cost would be too great, and not practical because a sheathing composed of an alloy requisite to resist the corrosive action would be so hard that the cable would be very rigid, especially cables of large diameters.

A great deal of my time has been taken up by laboratory experiments on the subject of finding a way to protect pure lead from these corrosive vapours and gases.

The fruit of these experiments is a compound that resists this chemical action. This compound, by a very simple process is applied to the lead sheathing during the process of encasing the cable, adheres intimately to the lead when of the proper consistency, is perfectly pliable regardless of temperature, and will not crack or peel off. In addition to all of these sterling qualities it has also the advantage of being a perfect insulator. Messrs. Tatham and Bros., cable manufacturers, of Philadelphia, will apply this compound to all of their cables that are to be laid in creosoted wood. Some, no doubt, will surmise that my compound is rubber or some of its compounds; to those, suffice it to say that rubber in no form enters into its composition. It is composed of mineral substances and hydrocarbons. This material is inexpensive both in its first

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cost and in its application as a protective covering to lead, and seems to solve the problem of effectually protecting lead from corrosion in creosoted conduits.—*Electrical World.*

ELECTRIC TRAMCARS.

On Monday, the 17th inst., before the Barrow Scientific Literary and Field Naturalists' Club, M. Stables, Esq. (president), in the chair, Mr. E. Thornton, secretary, gave a lecture, of which the following is an abstract :—

Although matters relating to electricity may generally be looked upon as being quite scientific, yet I hope to-night to so treat the subject we have in hand that it not only loses most of its scientific dryness, but rather be socially interesting. Electricity has now so far advanced in its applications, until one can scarcely mention a want but that can in some way or other be supplied electrically. However, as this evening is to be devoted to the using of this strange and subtle force for the propulsion of tramcars, we must not wander too far from the subject.

Before going further I think we might, perhaps, with advantage lay down a few of the conditions which we think an electric tramcar should fulfil. Then, when our experiments and tests are over, and we find that these conditions are complied with, one may say, "There has to-night been made a 'case' for electricity, as the agent of force, for the propelling of passenger-cars through our busy and crowded thoroughfares. If, on the other hand, we cannot comply with part or all of these said conditions, then we, for the present at least, leave the older means of travelling 'masters of the road.'"

Conditions.—1. The electric car should be capable of travelling at the speed allowed as limit by the Board of Trade. 2. That it should be as easily controlled as either horse or steam cars. 3. There must not be any danger either to life or property. 4. There should not be any funnel or chimney emitting smoke, steam, cinders, or ashes, and certainly not sparks. 5. Should not require any more manual labour in its manipulation. 6. Should travel without any undue noise. 7. The cars should be clean, comfortable, and *well lighted.* 8. The track construction should not be bound by hard and fast lines to one principle, but be capable of variation in the mode of laying, according to outside circumstances. 9. The cost per car mile should certainly be less than horses, and, if possible, as low as steam.

Although we have here rather a formidable array of conditions, yet I think during the evening we shall not find it very difficult to comply with most of them, if not all. There are not many of us who have not in our younger days been the proud possessors of a magnet or loadstone, and as we have amused ourselves attracting small particles of iron and steel we may have thought this was really a source of power, which only lacked the knowledge of how to apply it. Possibly also some of us have spent some time in trying to find how we could in some way utilise this magnetism for mechanical motion, but I feel sure the result was nil. Why, I will try to show.

Mr. Thornton then experimented with various permanent magnets showing the power of induction; graphically illustrated the lines of force and the condition of magnetic bodies when being acted upon; also explaining what a magnetic body was; how and why it was acted upon. A few experiments were also tried with the object of getting a continuous rotary motion from permanent magnets.

The electric current was next treated, its action demonstrated, and experiments made showing its influence upon iron. The wire was wrapped round a piece of iron rod, and the currents sent through the wire, making a powerful electro-magnet, which was now described as being magnetism under perfect control, which could be strengthened, weakened, or stopped at will. This magnet was now adapted to a simple motor, and rapid rotation was the result, but on testing for tram use it was found to be useless, because of dead points and excessive expenditure of current. By following up the various defects, the Gramme armature was arrived at, and on theoretically testing was found to be very suitable for tram work. To test, however, it was fitted to a small model tramcar, and on applying the current the car travelled beautifully over a track of 12ft., with an arrangement for reversing the armature current at each end, causing the tram to travel from end to end of its track at quite a rapid rate.

Means of conveying current were next considered, and the following systems tried by experiment on the small car: centre-rail or conduit conductor, overhead, side-rails as conductors, and storage cells. The car was found to work almost equally well under all conditions.

The lecturer then explained the advantages and disadvantages of each system, giving illustrations of electric trams that are in use.

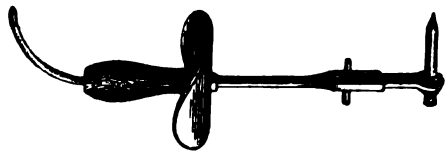
The cost per car mile was next considered. Reports of various tram companies furnished car-mile costs, which was found to be as low as 2d. in the most favourable condition possible—so high as 6d. under not so favourable circumstances. These results were thought to compare very favourably with horse traction. Steam was certainly called upon to look to its laurels if that was to be the future agent for tram travelling. The conditions were then examined, with the result that electric cars were unanimously considered as the future system.

Current was supplied from a small dynamo, and also from batteries; diagrams were used for illustrating theories, and sketches on the blackboard made most points quite clear. Numerous questions were asked by members, and answered very satisfactory.

The usual vote of thanks terminated the evening's gathering.

A SOLDERING-IRON.

The illustration shows a novel use of the electric current to be used with a soldering-iron. The figure explains itself. Of course, the greatest resistance is at the point of



the tool, as that is the part it is intended to keep hot. If the use of electricity for light and power becomes common, such a tool as this will be of great service in many industrial operations.

SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

OFFICERS AND COUNCIL FOR 1889.

Elected at the meeting held Thursday, December 13.

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NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

ELECTING THE COUNCIL.

At the last meeting of the Institution of Electrical Engineers, as it is to be called, a little liveliness was generated in what would otherwise have been a dull evening by the speech of Mr. W. H. Preece, past president. The meeting was, as all members know, that at which the Council for the ensuing year was elected. It had been arranged that, instead of a desultory conversation during the counting of the ballot papers, the reply of Mr. Edmunds to the discussion on his paper, read at the previous meeting, was to be taken. This reply needs little comment, inasmuch as Mr. Edmunds admitted having modified his apparatus considerably since the opening of the discussion, hence any reply to be of service should describe accurately the modifications adopted and the practical result of such adoption. The time has not arrived for this information, so we proceed to examine the position Mr. Preece has taken in regard to the election of Council. Our readers will be somewhat familiar with it, in that it agrees in the main with the views expressed in our issue of November 23rd last. Mr. Preece, in his exceedingly able and lucid speech, put the matter in a nutshell. The procedure of other societies was referred to, but whatever method be adopted it is open to objection. The best course is to select the method least open to objection. Two plans have been tried by the society, and, all things considered, the old one is preferred by many, notwithstanding the objections raised against it. Any large institution connected with technical matters must include within its membership men whose work is connected with special branches of the industry. The society, as a whole, is, in fact, the aggregation of a number of sections. In an industry like that connected with electrical work, the rapid development gives rise to new sectional interests, and it is in the interest of the Institution and the members that each sectional interest be duly represented upon the Council. What is the best method of selection in order to have every sectional interest thus represented? Till within the past three or four years the Council itself was accustomed to select names and issue a house list, which was submitted to the members for approval. Any member had the power before the period for selection arose to notify his ideas as to representation to the Council; he could suggest names to be considered for the house list, or when that list was issued he could strike out any name desired, and substitute any other in its place. This plan of selecting the Council involved an opposition acting in combination, to oust an unsatisfactory selection of the Council, and to put another man in the place. It was usually felt that united action of this kind necessarily meant practically a vote of want of confidence—hence we never remember it being [illegible] effect. What was done was that

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active spirits early suggested names to individual members of the Council for consideration in full Council, and we know of no time when such suggestions were not duly considered. The rapid development of electric lighting early in the eighties led certain members, who knew little and cared less about old associations centreing around the Institution, to agitate against the system described. They wanted a greater sprinkling of the modern section representatives, and no doubt justly so. They thought the Council was too conservative, and went too much upon the old lines, and in deference to these wishes the method of electing the Council was changed. A list of names of eligible candidates is given in the house list, and the members by ballot select out of these names those they desire as representatives. An admirable plan, but, like most others, open to grave and serious objections. In the first place, it is stated that the most eminent men will not always agree to undergo the tortures of a ballot. Then we are told that the rejected have not, after rejection, so warm a feeling to further the interests of the society as they had before. This, in our estimation, is the vital objection to the system. There is still, and will long remain, a "good deal of human natur in man," and no one in this mundane sphere can possibly look upon things in the same light after rejection as they did before it. A certain amount of conceit exists in everyone, and, though speakers cynically dubbed the rejected who felt hurt at the rejection as "too thin-skinned," we do not believe the term the right one to be applied. On the one hand, we have the Council—and this body contains the most experienced members of the society—certifying that a given name is that of one who would confer honour upon the society by being elected upon the Council; and on the other hand, we have a few irresponsible, inexperienced youths deciding the comparative merits of the names upon the list. We shall not attempt to mince matters, but say that in no single instance since this system of election has held, but that better men in every respect have been rejected than some of those elected. Unfortunately here, as elsewhere, the power of voting is exercised only by a small minority. This minority consists, as we say, in part of young members who have no knowledge of the men in sections of the industry other than their own, and ofttimes the merest rudimentary knowledge of the men in their own section. Numbers of these men vote, if not to dictation, to careful manipulation. Concrete examples are better than abstract quibbles, so let us take one section—the professorial. Almost every professor in the society is a member of the Council. Is this true representation? or does it not savour rather of over representation? The reply that every man among this section is *par excellence* an able, competent man, worthy of the position, conferring an honour upon the society, may be true and indisputable, and we shall not venture to deny it, but we do deny it to be representation. It is an absolute professorial autocracy. There is no personality intended in these remarks; the general argument only is in view. If it is desirable to have every section worthily represented, we cannot have every man in one section elected. That must lead to some section being given the cold shoulder. As a rule, any professor whose name is in the list is certain of election. His own old and present pupils, if they have the ordinary *esprit de corps* that should be a byeword with them in all that concerns their *alma mater*, together with the proportion of outside votes usually obtained, places success beyond doubt. The names of those who have a ripe experience in other sections, are unknown to the majority of those engaged in electric lighting. The sympathies of these newcomers into the society and the industry are wholly in one direction, as the result of the ballot testifies. The new members, however clever they may be, cannot be expected to have old heads on young shoulders, and though we always require pluck, energy, and go, to be well represented, we must not forget at the same time that these things are frequently the idiosyncrascies of inexperience, and necessitate the more conservative frame of mind, which comes from experience, to temper and direct the actions of youth.

A few years ago the cry was that the society's Council consisted wholly of telegraphic interests—land and submarine. Where are those interests represented now? Singular to notice, not one single elected member can be said to represent either section. It is all very well to say the past-presidents represent telegraphy. They are not expected to continue their labours for ever; and it would but be following precedent if Mr. Preece and Mr. Graves were to rest on their oars, and say "We have for many years devoted time and energy to the interests of the society, but now Nature demands a cessation from such arduous labours and requires a little more repose." From our own particular standpoint we ought to rejoice in the great show made upon the Council by electrical engineers devoted to the lighting and power sections. This narrow view is, however, unfavourable to the interests of the Institution, and we hope extended discussion may show a way out of the difficulty. The whole question is too long to be fully considered in our article; and we hope it will be freely discussed by members, whose views on the subject we shall be glad to receive, and at a subsequent time return again to the subject.

Frankfort.—The electric railway from Frankfort to Offenbach will be shortly lighted by arc lamps along the whole route.

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DYNAMO REGULATION BY MEANS OF A THIRD BRUSH.*

BY EDWARD CALDWELL, A.B., M.E.

The following study of methods of third brush regulation of series dynamos for *constant current* was taken up at the suggestion of Prof. Nichols. During the progress of the experimental work it was discovered that a similar method of regulation might be applied to a series-wound dynamo for the production of a *constant E.M.F.* The investigation was made to include, therefore, the applicability of this method of regulation to a series-wound dynamo, both for a constant current and a constant E.M.F.

The dynamo used in this work was a small series-wound machine, with two upright field-magnets of the Edison type and a Gramme armature. The cores and yoke were of the best Norway iron. The principal dimensions and constants of the machine were as follows:

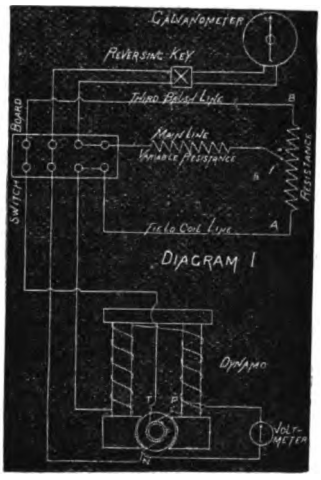
Diameter of armature, outside	4¾ inches
Length ,, ,, ,,	2¼ ,,
No. ,, ,, coils	30
Resistance ,, through brushes	·72 ohm.
Diameter of field-magnet cores	2⅝ inches
Length of field-magnet cores	7⅜ ,,
Size of yoke	2″ × 2⅜″ × 10½″
Turns of wire on each field-core	785
Resistance of each field-coil	·8 ohm.

A third brush, held by an independent brush-holder, was placed upon the commutator between the regular brushes. This could be set at any desired angle in advance of the positive brush, a pointer indicating the angle upon the graduated circumference of a wooden ring placed concentrically with the shaft. Another pointer indicated in a similar manner the angular lead of the regular brushes. Each of these pointers was set at zero of the graduated scale when the brush which carried it rested at the upper end of the vertical diameter of the commutator—a point midway between the edges of the pole-pieces.

The field was explored for distribution of potential around the commutator by a modification of a method described by Prof. Brackett in a paper read before the American Institute of Electrical Engineers in 1884, and published in vol. 1 of the *Transactions*.

The current was measured by a tangent galvanometer, the coil being formed of a single ring of copper, 50 centimetres in diameter, and of rectangular cross-section. Its constant was determined by comparison with the large standard tangent galvanometer in the Magnetic Observatory of Cornell University. The deflections could easily be read to tenths of a degree.

The E.M.F. was measured by an Ayrton and Perry voltmeter which had previously been calibrated. The voltmeter was shunted across the regular brushes of the machine



The resistances used in the external circuits were made of german silver wire coiled in the form of a spring, and stretched upon upright wooden frames. By means of a copper hook, contact could be made at any desired point. These coils were standardised by comparison with the coils of an Elliott Bros. resistance box of the dial pattern.

* Revised abstract of graduating thesis, Sibley College, Cornell University, June, 1888.

The arrangement of the apparatus during the first portion of this investigation differed from that of the Waterhouse Electric Company, in their system of third brush regulation for constant current, only in that the point of contact of the main line with the resistance coils of the regulator was varied by hand instead of by automatic means.

The connections used are shown in diagram I. The switchboard contained eight small mercury cups—two each for the terminals of the galvanometer, the third brush line, and the main line, and was so arranged that the galvanometer could be placed in any one of the three circuits.

The machine was first run at 2,500 revolutions as an ordinary series machine with two brushes, these being adjusted to the non-sparking position with a lead of about 12deg. Table 1 gives the data obtained from which the characteristic curve in plate A is plotted.

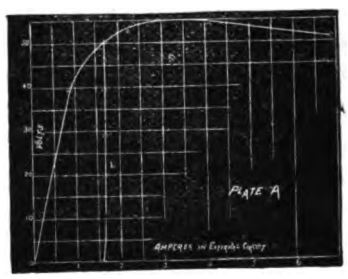
TABLE 1.

Volts.	Amperes.	Volts.	Amperes.
11	·21	55·1	3·09
39	·87	54·6	4·11
49	1·54	51·	6·90
54	2·35		

It will be noticed here that a very small amount of current is sufficient to saturate the field-magnets, because of the very large number of turns of wire on the field-coils.

With the third brush upon the commutator, a study was made of the effect of increasing the angular distance between the third and positive brushes. The tabulated results are given in tables 2 to 6. The third brush remained fixed through each set of observations, and the main brushes, at a lead of 12deg., through all the five sets. The resistance between the third and positive brushes was 21 ohms.

The curves of relation of E.M.F. and current, of which curve *b*, plate A, is an example, need not be plotted, as an inspection of the tables will show that within the limits of regulation, the curves are superposed vertical lines, if the volts be taken as ordinates and the amperes as abscissæ. Curves 1 to 4, plate A, are plotted from tables 2 to 5.



These curves are straight lines, and they show that the condition necessary to constancy of current in a series dynamo—namely, direct proportionality of external resistance and current in the field coils—has been secured. They also show that the greater the lead given to the third brush, the greater the field current necessary to keep the external current constant, the external resistance being the same. This will also be seen by a comparison of columns 3 and 7 in tables 7 to 10. These tables are compiled from tables 2 to 6.

But the most interesting, as well as the most important, phenomenon shown by all of these tables alike, is the change of sign of the current in the third brush line. Under some conditions the third brush acts as a positive brush, and under others as a negative.

Tables 2 to 6 show (1) that with each position of the third brush, on increasing the external resistance, the current in the third brush circuit at first decreases, becomes zero, and again increases in the opposite direction; and (2) that the further the third brush is in advance of the positive, the higher is the current in the third brush line at first, the sooner the zero point is reached, and the higher the current rises in the opposite direction.

Tables 7 to 10 show (1) that with advance of the third brush, the external current and resistance being kept constant, the E.M.F. continues to rise while the current in the third brush line gradually decreases, passes through zero, and again increases in a negative direction; (2) that this zero point is also the point of maximum additional

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TABLE 2.

Volts.	Amperes main line.	Amperes field line.	Amperes third br. line.	Ohms in main line.	Extra res. in field.	Angular advance of third brush. deg.
11·	1·70	·39	1·31	5	16·5	24
29·	,,	·77	·93	10	12·9	—
39·	,,	·99	·69	15	9·4	—
46·1	,,	1·47	·23	20	5·1	—
50·	,,	1·68	·02	25	1·4	—

TABLE 3.

7·	1·70	·29	1·41	5	19·3	48
29·	,,	·78	·92	10	15·1	—
41·2	,,	1·12	·58	15	12·0	—
49·	,,	1·52	·18	20	7·9	—
52·3	,,	1·84	-·14	25	3·0	—
53·5	,,	1·96	-·26	30	0·	—

TABLE 4.

12·	1·70	·35	1·35	5	20·	72
35·	,,	1·01	·69	10	16·8	—
47·7	,,	1·48	·22	15	11·4	—
51·6	,,	2·05	-·35	20	6·5	—
53·4	,,	2·35	-·65	25	2·3	—

TABLE 5.

43·	3·23 (?)	1·09	2·16	5	21·	96
47·	1·84 (?)	1·24	·60	10	21·	—
53·5	1·70	2·13	-·43	15	10·	—
55·1	,,	2·61	-·91	20	5·	—
55·0	,,	2·76	-1·06	25	2·5	—

TABLE 6.

51·	1·70	1·88	-·18	5	21·	120
54·3	,,	2·61	-·91	10	12·	—
55·1	,,	2·68	-·98	15	9·9	—
55·3	,,	3·08	-1·38	20	4·7	—
55·3	,,	3·37	-1·67	25	1·7	—

TABLE 7.

29·	1·70	·77	·93	10	12·9	24
29·	,,	·78	·92	—	15·1	48
35·	,,	1·01	·69	—	16·8	72
47·	—	—	·60	—	21·0	96
54·3	1·70	2 61	-·91	—	12·0	120

TABLE 8.

39·	1·70	·99	·69	15	9·4	24
41·2	,,	1·12	·58	—	12·0	48
47·7	,,	1·48	·22	—	11·4	72
53·5	,,	2·13	-·43	—	10·	96
55·1	,,	2·68	-·98	—	9·9	120

TABLE 9.

46·1	1·70	1·47	·23	20	5·1	24
49·0	,,	1·52	·18	—	7·9	48
51·6	,,	2·05	-·35	—	6·5	72
55·1	,,	2·62	-·91	—	5·0	96
55·3	,,	3·08	-1·38	—	4·7	120

TABLE 10.

50·	1·70	1·68	·02	25	1·4	24
52·3	,,	1·84	-·14	—	3·0	48
53·4	,,	2·35	-·65	—	2·3	72
55·0	,,	2·76	-1·06	—	2·5	96
55·3	,,	3·37	-1·67	—	1·7	120

TABLE 11.

1·	1·00	·10	·90	5	18·7	36
10·	,,	·32	·68	10	16·6	—
28·	,,	·40	·60	15	13·0	—
29·	,,	·62	·38	20	11·8	—
38·	,,	1·00	·0	30	4·0	—
40·5	·92	1·07	-·15	40	0·	—

TABLE 12.

5·	1·50	·31	1·19	5	17·4	36
25·4	,,	·49	1·01	10	14·9	—
34·0	,,	·83	·67	15	11·5	—
41·2	,,	1·22	·28	20	6·0	—
45·	1·38	1·56	-·18	30	0·	—

TABLE 13.

14·0	2·00	·48	1·52	5	16·5	36
34·5	,,	·81	1·17	10	13·0	—
44·	,,	1·38	·52	15	6·8	—
47·5	,,	2·00	·0	20	0·4	—
45·0	1·38	1·56	-·18	30	0·	—

TABLE 14.

25·	2·50	·61	1·89	5	15·8	36
43·6	,,	1·50	1·00	10	9·0	—
47·7		2·38	·12	15	1·7	—
48·0	2·14	2·22	-·08	20	0·	—

resistance in the field, and of minimum additional resistance in the third brush line; and (3) that this zero point is reached sooner the higher the external resistance.

It was at first thought that these changes might be due to a distortion of the neutral line of the armature, since with each change in external resistance there was a corresponding change of strength of field, while the current flowing up through the armature from the negative brush remained constant. An exploration of the field, however, by the method alluded to, showed that under extreme variations of current in the field the neutral line did not change position as much as 10deg.—an amount quite insufficient to account for the changes shown in the tables.

It will be noticed that the application of the third brush destroys the symmetrical flow of current in the armature. If the third brush be positive, it will take off a part of the current flowing up on that side of the armature, and the coils lying between the third and positive brushes will have less current than the other coils. But if the third brush be a negative, the current returning to the armature by the third brush line will be added to the coils lying between the third brush and the positive. Neither will the current flowing up on one side of the armature be equal to that on the opposite side, since the resistances of the two paths offered to the current are not equal. The result of this unequal distribution will be, in extreme cases, to throw the neutral points of the armature off the ends of a diameter and on that side of a diameter where the coils are traversed by the weaker current. If, however, as was the case with the machine used in this investigation, the magnetic moment of the field is very great as compared with that of the armature, this effect is inappreciable.

But these variations of current in the third brush line may be satisfactorily explained without reference to the distortion of the diameter of commutation. It is a well-known fact that the total E.M.F. generated in the armature coils increases around the commutator from the negative brush to the positive, each coil adding its share to that induced in the coils preceding, and that the E.M.F. again falls, through the same range, from the positive brush around the external circuit to the negative brush.

Let E_d be the drop of potential between the positive brush and the point at which the third brush line joins the main circuit, and let E_t be the rise of potential between the third and positive brushes—that is, the E.M.F. induced in the coils which lie between these brushes.

It is evident that if $E_d = E_t$, no current will flow in the third brush line, its two ends being at exactly the same potential. But if $E_d > E_t$, the third brush will be at a point of higher potential than the other end of the third brush line, and current will flow *out* of the armature through the third brush. If $E_d < E_t$, the reverse effect will be produced, and current will flow along the third brush line *into* the armature.

Now $E_d = C' R'$, where C′ and R′ are respectively the current and resistance of that part of the circuit between the positive brush and the junction of the third brush line with the main line. Also,

$$E_t = \frac{2}{\pi} w H' A'$$
$$= 4 n H' A'.$$

A′ being the "equivalent area" of the coils lying between the third and positive brushes; H′, the strength of field; w, the angular velocity; and n, the number of revolutions per second of the armature.

There will be equilibrium between the ends of the third brush line when $E_d = E_t$, that is, when

$$C' R' = 4 n H' A'.$$

The speed remaining constant, this equation shows that any one of three changes will make $E_d > E_t$, and so make the third brush positive.

(1) *Increase of* R′.

This will occur if the finger, *f*, diagram I, be moved toward the point B. This change will produce a corresponding decrease of C′ and H′, but below the saturation point these practically vary in direct proportion, and will not change the value of the equation.

(2) *Decrease of* A′.

This may be done by bringing the third and positive brushes nearer to each other, thus decreasing the number of coils between them.

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(3) *Increase of* C′, the field-magnets being saturated.

If H′ remain practically constant because of the saturation of the iron, an increase of C′, caused by a decrease of the resistance of the external circuit, will make $E_d > E_t$.

The three opposite changes will make $E_d < E_t$, viz.:

(1) *Decrease of* R′.

(2) *Increase of* A′.

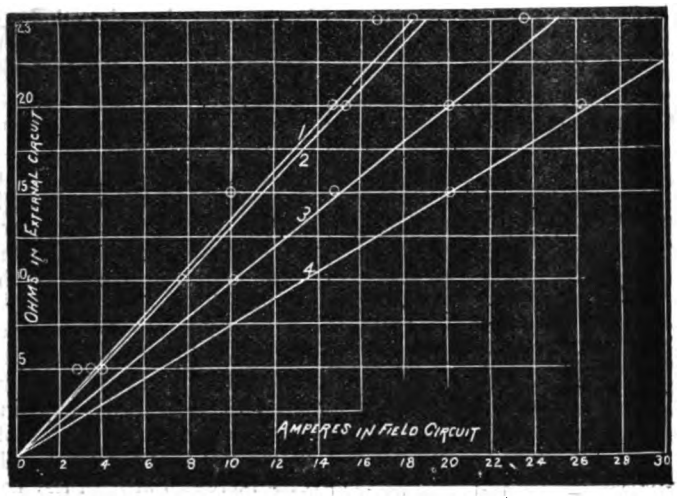
(3) *Decrease of* C′, the field-magnets being saturated so that H′ remains constant.

A change of speed, *n*, would produce a complex change in all of the factors, except A′. All of the variations of current in the third brush line may be traced to one or more of these causes.

current was held respectively at 1·0, 1·5, 2·0, and 2·5 amperes. The points obtained by plotting field current with E.M.F. fall, as before, upon a common curve, as shown in plate B, and the constant current curves for 1·0, 1·5, 2·0, and 2·5 amperes cross this curve at 38, 44, 47, and 47·5 volts E.M.F. A curve for ·5 of an ampere would cross the characteristic at about 22 volts.

Below the saturation point of the iron, the relation between current in the third brush line and E.M.F. is one of direct proportion. When the saturation point is reached, current in the third brush circuit may increase indefinitely without increase of E.M.F.

No very large *negative* current is obtained in the third



Curves 1 to 4, Plate A.

It will be noticed that the difference of potential between the main brushes is always the same—between 50 and 51 volts—when the current in the third brush line changes sign. This is the point at which the new characteristic crosses the characteristic of the regular series machine, as shown in plate A, where the characteristic curves from tables 1 and 2 are plotted together. When the third brush is positive it robs the field-coils of a part of their current and adds this to the main line current, and when it is negative it diverts a portion of the current from the main line, adding it to the field circuit line.

It will also be noticed that curves plotted between field current and E.M.F. from tables 2 to 6, coincide with the characteristic from table 1. This would necessarily be so, since in table 1 the external current is also the field current.

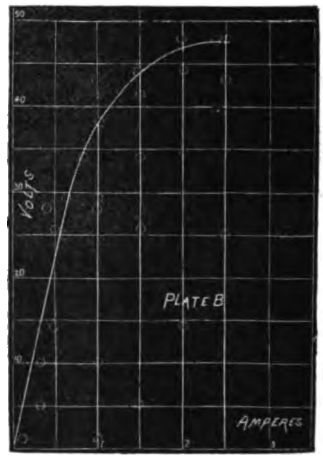
No higher E.M.F can be reached on the constant current curve than that obtained from the machine worked as an ordinary series dynamo, the limit being reached as soon as the iron of the field-magnets becomes saturated.

The horizontal distance between corresponding points on the constant current curve and on the curve of E.M.F. with field current, measures the amount of current flowing in the third brush line at that point, and also shows whether it is positive or negative.

It is evident that the point of crossing of the two characteristics—that is, the point at which the current in the third brush line becomes zero—will depend upon the *amount* of the constant current in the external circuit. Tables 11 to 14 give the data obtained when the external

brush line until the third brush is 90deg. or more in advance of the positive. This would seem to indicate that the constant current characteristic cannot be carried much, if any, above the regular series characteristic unless the third brush has a very large lead, and this is objectionable because of very bad sparking at the third brush.

This arrangement is in reality equivalent to a compound-wound dynamo in which one set of field-coils is made to carry the current for both the series and shunt-coils of the usual type of compound-wound machine. Referring to diagram I., and the last line of table 4, it is clear that the field-coils act as *series* coils in carrying a current of 1·70 amperes from P, the positive brush, around the external circuit to the negative brush, N, and that at the same



time they act as *shunt* coils in carrying ·65 of an ampere from P, around the field-magnets and back to T, the third brush. There is, however, this further distinction to be made between this arrangement and the usual type of compound dynamo—that that part of the field current which partakes of the character of a shunt becomes zero under certain conditions of the external circuit, and that beyond this point the shunt circuit acts as a differential coil wound upon the field-magnets. This is effected, not by an opposing current being sent around the field, but by the shunt

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becoming a *shunt around the series field-coils*, thus depriving them of a part of the current they would otherwise receive, and so weakening the field. This is is shown by the first line of table 4, where, of the 1·70 amperes in the external circuit the field-coils carry but ·35, while a current of 1·35 amperes is shunted around the field by the third brush line and added to the current in the main circuit. Though common enough in motors, the writer is not aware of any other case in which a differential coil or anything analogous to it is applied to a generator.

The arrangement then embodies at once the principles of three distinct types of dynamos, the type used being determined solely by the resistance of the circuit if the external current be kept constant. In keeping a constant external current, however, the resistance of the series field changes.

These three types are :

1. Series dynamo + differential shunt-coils (or rather what has the same effect as differential shunt-coils).

This type is brought into use when the third brush is at a higher potential than the junction of the third brush line with the main line and a portion of the total current of the armature is diverted from the field-coils, decreasing the strength of field.

2. Plain series dynamo.

This is the type made use of when both ends of the third brush line are at the same potential and the current flowing in it is *nil*, which occurs at the point of intersection of the two characteristics.

3. Series dynamo + cumulative shunt-coils.

This occurs when the junction of the third brush line with the main line is at a higher potential than the third brush and current flows into the armature at the third brush.

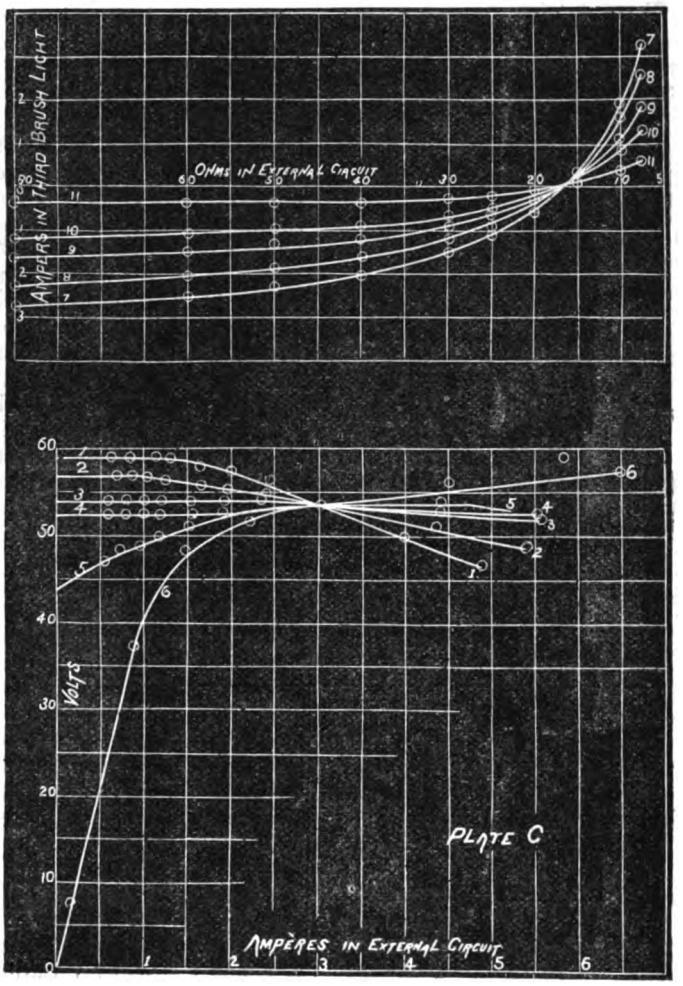
It should be noticed that in this combination the total resistance of what corresponds to the shunt circuit of the field, including the resistance of the field-coils and whatever resistance may be placed between the third brush line and the field line, is a constant, while the resistance of what corresponds to the series circuit of the field is variable, being changed by the movement of the finger, *f*, diagram I, along the resistance, A B.

The requirements for constant potential regulation are radically different from those necessary for constant current. Recurring again to Prof. S. P. Thompson's fundamental equation of the dynamo,

$$E = 4nAH,$$

where n and A are both constant, it is evident that if E is to be a constant, H must also be a constant. Hence, for constant potential regulation the exciting current of the field-coils must a constant.

It is believed that the method here described for obtaining this result has not before been applied for this purpose. The arrangement is a very simple one, as shown in diagram II. The third brush line passes through a low resistance and is joined to the main line at the positive terminal of the machine—just outside the field-coils. In this case either no resistance or a very low one is placed between the third and positive brushes, and no automatic arrangement is necessary, as the point of junction is a fixed one. Diagram III. shows the connections as used in the experimental work.



The effect of using different resistances in the third brush line is shown by tables 15 to 19, and curves 1 to 5, plate C, plotted from these tables. The third brush remained fixed at 30deg. in advance of the positive brush, this being given as before, 12deg. lead. Curve 6 of the same plate is plotted from table 20, and is the characteristic of the machine run as a series dynamo, reduced to the same speed as tables 15 to 19.

TABLE 20.

Volts.	Amperes.	Volts.	Amperes.
8	·20	53·5	3·06
37·3	·88	56·2	4·53
48·2	1·48	59·0	5·83
51·6	2·22	57·2	6·50

Curves 7 to 11 of plate C, are plotted from tables 15 to 19 with external resistances as abscissæ, and current in the third brush line as ordinates, and correspond respectively to

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curves 1 to 5. Negative current is plotted below the axis of X and positive current above.

TABLE 15.

Volts.	Amperes in main line.	Amperes in field line.	Amperes in third br. line.	Ohms in main line.	Ohms in third br. line.	Angular advance of third brush deg.
59·	·63	3·37	-2·74	80	Only the	36
59·	·84	3·40	-2·56	60	lead	—
59·	1·14	3·42	-2·28	50	wire.	—
59·	1·29	3·31	-2·03	40	—	—
58·	1·64	3·16	-1·52	30	—	—
57·5	2·00	3·12	-1·12	25	—	—
56·4	2·44	3·01	- ·57	20	—	—
53·5	3.10	2·78	·32	15	—	—
50·	4·00	2·12	1·88	10	—	—
46·4	4·87	1·64	3·23	7·5	—	—

TABLE 16.

57·	·68	2·95	-2·27	80	1	36
57·	·87	2·93	-2·06	60	—	—
57·	1·05	2·89	-1·85	50	—	—
56·5	1·25	2·88	-1·64	40	—	—
55·8	1·66	2·84	-1·18	30	—	—
55·2	1·96	2·86	- ·90	25	—	—
54·8	2·40	2·86	- ·46	20	—	—
53·5	3·08	2·80	·27	15	—	—
51·	4·40	2·83	1·57	10	—	—
48·5	5·40	2·82	2·58	7·5	—	—

TABLE 17.

54·	·60	2·23	-1·63	80	2	36
54·	·81	2·30	-1·49	60	—	—
54·	1·01	2·32	-1·31	50	—	—
54·	1·19	2·37	-1·18	40	—	—
54·	1·55	2·46	-·91	30	—	—
54·	1·91	2·56	-·65	25	—	—
54·	2·37	2·69	-·32	20	—	—
53·5	3·09	2·89	·20	15	—	—
53·	4·40	3·33	1·07	10	—	—
52·	5·58	3·75	1·83	7·5	—	—

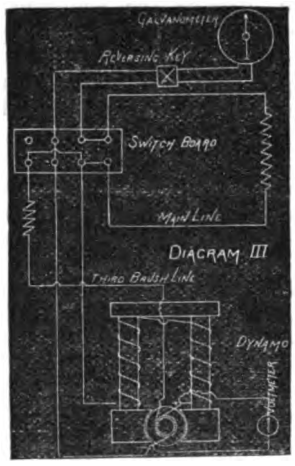
TABLE 18.

52·5	·61	1·79	-1·18	80	3	36
52·5	·79	1·90	-1·11	60	—	—
52·5	·97	1·97	-1·00	50	—	—
52·5	1·17	2·05	- ·88	40	—	—
52·5	1·55	2·19	- ·64	30	—	—
52·5	1·90	2·37	- ·47	25	—	—
53·	2·35	2·60	- ·25	20	—	—
53·5	3·06	2·86	·20	15	—	—
53·	4·40	3·59	·81	10	—	—
52·5	5·52	4·22	1·30	7·5	—	—

TABLE 19.

47·	·57	·91	- ·34	80	5	36
48·5	·73	1·10	- ·37	60	—	—
49·	·96	1·31	- ·35	50	—	—
50·	1·17	1·53	- ·36	40	—	—
51·2	1·53	1·80	- ·27	30	—	—
52·0	1·88	2·11	- ·23	25	—	—
52·8	2·28	2·40	- ·12	20	—	—
53·5	3·06	2·96	·10	15	—	—
53·5	4·42	4·08	·34	10	—	—
52·3	5·46	4·88	·58	7·5	—	—

These curves and tables show: (1) That the current in the third brush line is, at first, with high external resistance, negative, having its highest value when the external



resistance is infinite, or when the main line circuit is open; that with decreasing external resistances it gradually decreases, passes through zero, and again rises in the opposite direction; (2) that the point at which the third brush current becomes zero is independent of the resistance in the third brush line, becoming zero in each curve at exactly the same external resistance, and that this zero point is the point at which the new curve crosses the series characteristic; (3) that increase of resistance in the third brush line reduces the regulating power of the third brush, the curve at the limit coinciding with curve 6; (4) that increase of resistance in the third brush line decreases the field current, and consequently the E.M.F., but that the external current is practically independent of the resistance in the third brush line; (5) that the most constant E.M.F. is produced when the third brush line has a resistance of about three ohms—in this case about twice that of the field-coils. This resistance, however, will vary, not only with the resistance of the field-coils, but also with the angular advance given to the third brush and with the amount of current necessary to produce saturation—that is, with the quality and quantity of iron in the cores.

The explanation of these phenomena is slightly different from that already given for the changes observed in the case of constant current regulation. The same equation, however, is applicable. Using the same symbols as before, equilibrium will exist between the ends of the third brush line, when $E_d = E_t$, or $C' R' = 4 n H' A'$. In this arrangement R', which is here the resistance of the field-coils only, remains a constant. A decrease of A' by bringing the third and positive brushes nearer each other, or within certain limits, an increase of C', will make $E_d > E_t$ and make the third brush positive. If now A' remains constant and C' be increased by a decrease of the external resistance, H' will increase in direct proportion as long as the iron of the field-magnets is in the unsaturated condition, and there will be no change in the value of the equation, $E_d = E_t$. But as soon as the saturation point is reached, H' becomes practically a constant, and further increase of C' will make $E_d > E_t$ and the third brush positive. In tables 15 to 19 the field-magnets are fully saturated when $E_d = E_t$, and hence any increase of C' makes $E_d > E_t$. Had A' been much smaller this result would not have been obtained.

The two opposite changes will make $E_d < E_t$ and the third brush negative—viz., an increase of A', or a decrease of C'. A decrease of C', however, will produce this result only when, as before, the iron is fully saturated. This is shown in the first part of table 19, where the field current was not sufficient to produce saturation of the magnets and, as a result, the current in the third brush line remains practically unchanged, while C' undergoes considerable variation.

It is evident that the potential of the two extremities of the third brush line is independent of the resistance of the line, and hence any variation in this resistance will have no effect upon the point at which its two ends will be at equal potential. It does, however, determine the amount of current flowing in this line, and hence the amount flowing in the field-coils; since when the third brush is negative it adds its current to that of the field-coils, and when it is positive the current in it is shunted *from* the field-coils, as in the constant current regulation. This resistance must be low enough to allow of complete saturation of the field-magnets.

Here, again, we have an arrangement which is in reality equivalent to a compound-wound dynamo. Referring to diagram II. and the first line of table 17, it will be seen that the field-coils perform the part of series coils in carrying ·6 of an ampere from the positive brush, P, around the external circuit to N, and at the same time, as shunt-coils, carry 1·63 amperes from P around the field-magnets to T, the third brush. The same three types of dynamos are here brought into use—viz.:

1. Series dynamo + cumulative shunt-coils.
2. Plain series dynamo.
3. Series dynamo + "differential shunt" coils, and the conditions under which each is brought into use are precisely like those already met with in regulation for constant current.

As was pointed out in the discussion of the constant current regulation, the application of the third brush necessarily interferes with the symmetrical flow of current in the armature, those coils lying between the third and

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positive brushes carrying more or less than the other coils, according as the third brush is negative or positive. In properly-constructed dynamos this should produce no detrimental effect. It should, however, be taken into account in dynamo design when computing the size of armature wire from the amount of current it is to carry, for it is evident that in this case one-half the total current in the external circuit is not the maximum current which the armature-coils must carry. A similar remark applies to the size of wire for the field-coils.

A decrease of the resistance of the field-coils would decrease the loss of potential between the positive brush, P, diagram II., and the point B, and, the potential of T remaining constant, would increase the negative current in B, T, and, other things being the same, the lower the resistance of the field the lower the resistance of the external circuit must be made before B and T are brought to the same potential, or, in other words, before the new characteristic crosses the series characteristic; and if this point is not reached within the limits of the machine only the first of the three types of dynamos mentioned above is made use of. The same effect is produced by giving increased advance to the third brush, thus lowering its potential. Increased resistance of the field or decreased advance of the third brush will produce opposite effects. It will be found that whatever the field resistance or the advance of the third brush, there will be a corresponding resistance for the third brush line (and this, in conjunction with the field-coils, may be regarded as the shunt circuit of a compound dynamo), for which the machine will produce a constant E.M.F.

Prof. S. P. Thompson has observed that the efficiency of any compound wound dynamo for constant E.M.F. is very nearly a constant. Using his equation for efficiency, this is very nearly obtained from table 19 and curve 5, plate C, and this is probably very near the true curve for constant E.M.F. at the terminals of the machine, the volts here being the difference of potential between the brushes.

It is hoped that at some future time an experimental study, similar to that described above, may be made of third brush regulation for electric motors for both constant current and constant potential circuits. The field is an inviting one, and cannot fail to be productive of useful and practical results.

COMPANIES' MEETINGS.

WOODHOUSE AND RAWSON, LIMITED.

An extraordinary general meeting of the shareholders in Woodhouse and Rawson, Limited, was held last Friday at the Cannon-street Hotel, E.C., Sir John Stokes (the Chairman of the Company) presiding.

The **Secretary** (Mr. G. Shurmer) read the notice convening the meeting.

The **Chairman** said: Gentlemen, this meeting is called, though not strictly necessary, in order that we may have confirmed by you the Auditors that we have temporarily appointed, and also in order that we may let you know the arrangements that are in progress with reference to the extension of the business, and have your confirmation of the same. You will be glad to hear that since we had the pleasure of meeting you some six months ago we have gone on improving the organisation of the Company, which now we have got into good working order. In our installation department we have, during the past year, done work for Messrs. Peek, Frean, and Co., the London Stock Exchange, Lord Brassey, Messrs. Guinness and Son, Messrs. Crosse and Blackwell, Drapers' Hall, Exeter Asylum, Messrs. W. H. Smith and Son, the Institute of Medical Electricity, and many other important firms and companies, and we have at the present time in hand orders for lighting of the Palace of Mysore, Sir Federick Carden, Messrs. J. W. Benson and Co., extensions at the Drapers' Hall, together with other installations of varying degrees of importance. We are also in negotiation at the present time for the sub-contract for lighting one of the most important districts of London, which sub-contract, we expect, will come to considerably over £100 000. In our subsidiary company working in Yorkshire, besides having put up installations throughout the district, there are a number of establishments in Bradford at present being fitted up by them, there being over 20 places, such as the six principal banks, etc. Besides this large increase in our business there has been a striking advance in electrical business generally, and, as far as we can judge, there is likely to be a still greater increase. To give an idea of this growth, it may be mentioned that we have not yet in any way felt the large increase that there will be in electric lighting derived from such companies as the London Electric Supply Corporation, Limited, with its large works at Deptford, the Metropolitan Electric Supply Company, and many of the other central stations that are being now started. It must be recollected that Woodhouse and Rawson, Limited, and its subsidiary companies lay themselves out for working for companies of this description, and that we hope to obtain a large amount of work resulting from their increase. To give an instance of the extraordinary increase, we may mention that the turnover in electrical supplies of the Woodhouse and Rawson Electric Supply Company of Great Britain, Limited, one of our subsidiary companies which does a merchant's business in buying and selling electrical goods and goods connected therewith, has increased nearly threefold during the last six months. Foreseeing this increase some little time ago, the Woodhouse and Rawson Electric Manufacturing Company consulted us with regard to the extension of their company, as they quite saw that their company in its existing state would be unable to cope with their business, and it was arranged to enlarge the company. As an instance of this increase I may mention that they recently received an order for over 100,000 switches, the largest order ever given out. They also are in negotiation at the present time for an order for 200,000 incandescent lamps, and even at the double rate of their present turn-out these two orders would fill them up with work for many months to come in their respective departments. The manufacturing company also wished to obtain the advantage of an amalgamation with another well-known business in the North of England, which also had a very great increase of business, and was about to enlarge. We were in negotiation also ourselves for the purchase of various properties which we considered of value to our business, and on finding that the manufacturing company intended themselves to increase, we suggested their acquiring the properties we were in negotiation for. At this date there had been negotiations for some time between the Company and Mr. Rawson for the purchase of the founders' shares, as it was quite evident that, should the business go on as we expected, it was advisable for the Company to exercise its option and purchase these founders' shares. Our legal adviser told us, however, that it would be almost impossible to do this without the formation of a new company, as the Company could not purchase its own shares. Under those circumstances we considered it advisable to make an amalgamation, and we found that several other companies would be willing to join us. It may take a little time to complete this arrangement, but we wish to have the support of your approval to our doing this, on the basis that the shareholders receive a bonus upon the amount paid up on their shares, and that there will be certain assets left in our hands, from which we hope considerably to increase this bonus. At the present time we are paying dividends at the rate of 12 per cent. per annum, and we hope that by this amalgamation we shall be enabled to increase this dividend, as we shall not then be obliged to set aside the large amount we now have to pay to the founders' shares. As you can quite see, it will not do to give any details of this amalgamation until it is further forward. You may recollect that at the meeting about six months ago I stated that we had just completed an arrangement of great importance to us. I am glad to say that this arrangement is now finally completed and in every way carried through, but I am not yet at liberty to divulge the same, as the interests at stake are too important. There is a company coming out in a short time, called Elmore's Patent Copper Deposit Company, Limited, to work a process which we ourselves, as well as the most eminent experts in such matters, consider one of the most valuable inventions discovered for a long time. We have been engaged in this for the past few months, and feel confident of making a large profit from the same. With regard to the matter of auditors, the late Mr. William Spain had, before this Company was formed, acted for Messrs. Woodhouse and Rawson, and his firm, Messrs. Spain Bros., were appointed as auditors to our Company. We regret to have to say that since our last meeting Mr. William Spain has died, and we have appointed as auditors to the Company Messrs. Chandler, Pixley, and Co. and Mr. Champness, who, until shortly after Mr. Spain's death, was a partner in the firm of Messrs. Spain Bros., and who attended to Mr. William Spain's work. Messrs. Chandler, Pixley, and Co. are well-known auditors, and are already auditors to one of our subsidiary companies. It is necessary to have this appointment confirmed. The first point I will put to the meeting is, that Messrs. Chandler, Pixley, and Co and Mr. Champness be appointed auditors of the Company.

Mr. Hayes seconded the motion, which was at once carried.

The **Chairman** said he would now put it to the meeting, that they gave their moral support to the Directors in doing that which they had the power to do, but which was a matter of such importance that they preferred to have the confirmation and approval of the general body of shareholders. He referred to their amalgamating Woodhouse and Rawson, Limited, in a larger company, which would give them a wider field of action and held out every prospect of success.

The **Chairman** said he would ask Mr. Rawson to explain the position further.

Mr. Hayes: Will Mr. Rawson tell us that the interests of the shareholders will be safeguarded?

Mr. F. L. Rawson: I may state that the interests of the shareholders have been carefully looked after by the Directors, and naturally so, the Directors being amongst the largest shareholders, holding between them a very large proportion of the capital. We have done everything we could to make this new company such as will both command the amount of work that is necessary for such a company, and also bring in, as the Chairman stated, a larger dividend even than that paid before—that being done by the obliteration of the founders' shares.

Mr. W. Reed: Will it necessitate a voluntary winding up?

Mr. Rawson: I should think it would do so, but everyone will know that it is only a formal matter, on account of the business being carried over. Questioned as to the cause of the difficulty in selling shares readily on the market, Mr. Rawson said the Company paid dividends only on £70,000, and they could not, therefore, get a quotation, and people who wished to buy or sell had to wait the opportu-

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nity offered by someone else wanting to buy or sell shares at the same time. One great gain which would be obtained by the present scheme was that they would get a quotation.

The **Chairman**, replying to **Mr. Reed**, said that by the proposed arrangement the bonus could be taken in cash or shares in the new company, at the option of shareholders, for the amount of the old shares paid up.

Mr. Rawson said, in reference to the partly paid-up shares, they had at present arranged that the shareholders of Woodhouse and Rawson, Limited, should have a bonus of so much per cent. in the new company, according to the amount paid up on their shares at the date of the handing over, and, in addition, that Woodhouse and Rawson, Limited, should keep certain assets, and realise those assets and distribute them amongst their shareholders. There was an important matter to mention, and that was, that one of the largest holders of partly paid-up shares had seen him once or twice on the subject, who complained that it would be unfair that the shareholders who had, as he expressed it, borne the heat and burden of the day when the Company was first formed, and it was not known whether it was going to be a success or not, should not participate in the same way as the holders of fully-paid vendors' shares. Of course, it made the greatest difference to Mr. Woodhouse's executors and to himself (Mr. Rawson), but as regarded himself he had agreed with the Board that if any partly-paid shareholders cared to pay up on their shares before the arrangement was concluded they could do so, and in that case participate in the bonus. Therefore he believed he was right in saying the Board would be prepared to receive the amounts of unpaid shares, in which case the holders would receive the bonus on their shares in full and from the assets which were going to be realised; that was, in proportion to the amount they had paid up at the date of the amalgamation.

The **Chairman** stated that this was the case.

Mr. Reed: Will the dividend due now be sunk in the bonus of the new company?

Mr. Rawson: Not the dividend to be paid on the shares up to June 30. That will be paid when we get the Auditors' report passed by the general meeting.

The motion was agreed to, and the proceedings terminated.

SWAN ELECTRIC LIGHT COMPANY.

The sixth annual general meeting of the Swan United Electric Light Company, Limited, was held on Tuesday at the Cannon-street Hotel, E.C., under the presidency of the Chairman (Mr. J. S. Forbes).

The **Secretary** (Major S. Flood Page) having read the notice convening the meeting, the report and accounts were taken as read.

The **Chairman** said he would now invite the attention of the shareholders to the figures presented by the profit and loss account and the balance-sheet, because that really was the text of all reports. He proposed to deal with the profit and loss first. They would see that the debtor and creditor accounts were presented in much the usual form, and they had been long enough associated together in this matter to have tumbled into something like stereotyping the accounts under the different headings. They began always with the stock taken over in the previous year, which was valued and carried forward. Then came the purchases connected with the manufacture of lamps, the expenses of administering the Company's affairs, wages and expenses at factories, depreciation and balance. The balance, if there was any, in their early years showed an adverse figure; but, happily, in the last three or four years the figure had been to the good. On the other side of the account the substance of it was in one entry—sales, less commissions and allowances. Then there were the transfer fees and interest and stock; that was the stock of lamps on hand and material at the end of the current year. These few small entries made up really the kernel of their nut. The most important of them all was the sales, less commissions and allowances, £40,126. 6s. 10d.; that showed a considerable advance in the volume of business compared with the previous year—about £13,000 in round numbers. The transfer fees and interest account was about £330 less, and that interest they would see was derived chiefly from investments of cash in consols and other securities; they were in the happy position of having called up a certain amount of capital, and of that they had in hand a good round sum. It was no use keeping it in the strong boxes at the offices, and therefore they had invested it—they would see it was invested partially under an obligation in Germany, and the other amount in Prussian Consols—there was from this represented a certain interest, amounting to £1,314. Then there was the stock, £9,676 odd; that was £1,450 in excess of the corresponding year, so that those two added together—what they had sold and what they had made and put away—represented £14,450 more in volume of business than they had last year. Turning to the other side of the account, the stock carried over amounted to £8,221; purchases, £17,238—that was a compound item, embodying the material necessary to manufacture the large number of lamps that had been sold, and also including a considerable amount representing lamps which this Company had been obliged to buy of the company in England in which they were so largely interested, the Edison and Swan Company. Then there were office expenses, Directors' fees, rents, salaries, etc., £3,916; Mr. Swan's salary (less proportion payable by the Edison and Swan Company), £400; wages and expenses at factories, £11,922; depreciation, £1,079; and then the balance, £8,332. It would be seen that it was only £780 in excess of the balance of the preceding year, and, looking at the large additional volume of business, the analytical mind would of course want a reason for that; and he was about to give the reason. The one happy feature about it was that the £8,332 was unencumbered by a claim for previous losses. In the corresponding year they had to reduce by between £7,000 and £8,000 the profit they had made by writing down an amount outstanding against the accumulated losses of previous years, and that reduced the balance carried over to £1,720. Now, the £8,332 for this year was unencumbered by any such claim, and was transported bodily into the balance-sheet. But proprietors would naturally ask how it was that having done £13,000 more business, they had only got £780 more profit. Well, he must tell them that competition was going on rather severely on the Continent—probably not quite so severely now, since they had themselves become members of a considerable continental company; but still it had gone on, and the Directors had thought it prudent to meet that competition by, in fact, bending to the storm of it, and reducing somewhat materially the prices of the lamps, so that they had sold a larger number of lamps at a less price per lamp. They had taken, in fact, what they could get for them. That was one reason. Another was that in the valuation of the stock taken forward they had been a little more severe against themselves this year than in the preceding year. They took over the stock at a higher figure last year than they had done this; and they had thought it prudent—being more anxious for the permanent foundation on which their business was to rest than the profit of a particular year—they had thought it prudent, in face of the great competition, to carry forward the stock at a less price than they had done hitherto. That had made a material difference in that figure. They *might have* carried forward the lamps at a price even £3,000 *greater than they* had, but in face of the competition they had thought it wiser to carry forward the lesser sum. If they were able to get rid of them at anything like the price of last year, they would have a better result to show the shareholders in the next balance-sheet—in fact, it was a case of holding the bird in hand. These were the particular reasons why on an increased sale there had been a relatively small increase of profit. He would commend this to them as prudent people, if they had erred it had been on the right side. In the balance-sheet things remained pretty much as they were. The share capital was about the same; they had recovered the munificent sum of £2. 10s. from somebody whose call was in arrear, but that did not materially disturb the state of the capital. Sundry creditors were £2,943, which was about £2,000 less than in the corresponding year; then the balance on September 30, 1887, was £1,720, which was what remained of gross balance last year after deducting the claim which he had described as the accumulating losses of previous years. They now stood credited in the balance-sheet with £10,052. On the opposite side of the balance-sheet they would see cost of patent rights at exactly the same figure. On the formation of the Compagnie Générale des Lampes Incandescentes, as he explained at the extraordinary meeting held not very long ago, they had to expend a further sum of £930 on those patents by the agreement with their French competitors, but they had now become a portion of the Company, having its seat in Paris, and, having got rid of the litigation, were putting their shoulders together with a view to building up a business. That company appeared in the balance-sheet for 800 shares, which they had to take over as an equivalent to their share in the new company; the patent they put in. The £930 was largely made up of this: When a company in France transferred into a new company, it had to pay up all the accruing patent fees for the years unexpired. That absorbed the greater part of the £930, and the rest was made up by the legal expenses for drawing the important agreement into which they had entered. Then there was £15,838, representing the 800 shares of 500f. each, which they got as their proportion of the capital of that company, 1,000,000f. representing the patents which both companies put into the common pot. Last year, having an unsettled account with respect to the Lille factory on hand, they carried £3,000 to a special reserve. The Lille factory was now wound up, and they had brought the £3,000 from the reserve into this account, to the value of their outlay on factories and plant, which brought that item down to £5,396. Then they had carried against themselves the usual amount of depreciation, so that out of revenue, the outlay on factories, plant, etc., had been diminished to £4,317. They had got rid of the Lille factory, and the only factory on hand was the Kalk factory, near Cologne, on which a considerable amount of money had been spent, and which it was necessary to maintain, as there was a difficulty of carrying on the business in Germany, the law requiring that a patentee should produce in that particular country. That was put at £4,000; they had spent, perhaps, two or three times £4,000, but had written down year by year large depreciations, and 20 per cent. in five years would, of course, wipe out the whole thing. They had, at any rate, £4,000 representing the value of that factory for themselves or anybody else to whom they carried it over. The Directors contemplated being able to carry out the same arrangement with regard to Germany as they had in most parts of the Continent—to fuse the two interests on some terms or other, as he explained at the meeting for carrying out the fusion with the French company. Arrangements for this purpose were on foot, and would shortly be prosecuted. If that were carried out they would make their bow to the manufactures of Germany, and probably on the condition that their successors took over the Kalk factory at a valuation which he hoped would considerably exceed the £4,000. Then came the *bonne bouche* of the Company, the shares in the Edison and Swan Company. That remained, of course, unaltered, £208,478; next, the shares in the Compagnie Générale des Lampes Incandescentes, £30,489, £15,838 of which represented the value of the shares for the patents they brought in, and £14,651 the value of the 740 subscribed shares, meaning, in fact, the subscription capital of both companies to start the business in France—that made up the £30,489 which they had got in that company. Well, he was not going to prophesy, but their French colleagues, when they were over in Paris the other day, were very sanguine that it was a very good investment, and that the day was not very far distant when there would be a considerable, or at all events, a fair profit on that outlay. Two millions of francs was not a very large amount of money, to have become possessed of these patents and have started a business, and if they did a considerable business it

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would be a very satisfactory transaction. With regard to sundry debtors, he was glad to say that amount had been reduced by about £3,400 since last year; they had got the collections a little closer up. They were all good debts; there was no reason to believe there would be any loss on them. The next item was stock on hand, £9,676; that was brought from the profit and loss account, being the stock on hand on September 30, 1888. The figure had been arrived at, as he had explained, by a rather more severe statement against themselves in preceding years. Then came investment in Prussian Consols cost £5,120, investment in Consols Three per Cent. cost £1,987, investment in new Two-and-three-quarter per Cent. Consolidated Stock cost £20,000, and cash on deposit and in hand £13,927. They would see there was not an inconsiderable sum in the character of cash, or what could be turned into cash at any moment if they wanted it for the extension of their business—about £40,000, and that invested would bring in a moderate amount of interest for the benefit of the profit and loss account. He did not know that he need go further into the details of the accounts. Coming to the report, the two first paragraphs embodied all he had told them. The shareholders were reminded of the agreement with the Compagnie Continentale Edison, which was approved by an extraordinary meeting on June 5 last, and was also approved by those who had become their partners; all the legal formulary had been carried out, and the company was on its legs. The factory was designed by their friends in London, the French company being kind enough to give them credit for having more knowledge of what would be useful and desirable than themselves, and to accept their views as to the class of factory, machinery, and so forth, to be installed there. Meanwhile they were supplying them with lamps from Germany and partly from this country, until they were in a position to manufacture for themselves, which would probably be in February or March next. As to Germany, he had told them he hoped to bring the litigation to an end; that turned upon whether the negotiations now going on were successful—whether they could be induced in Germany to follow the lead of those in France, and putting their horses together extend the business under both patents combined. The Directors had been most anxious for two or three years to get rid of the litigation, and do that which had proved a wise thing in this country, and he thought would be wise there. They would notice from the report that two Directors retired. With respect to Mr. Swan, he apprehended that there would be no question as to the wisdom of re-electing him; but with regard to Mr. Stearn, the position of the business in Germany, with a possibility of their being absorbed within some short time by another company, had brought them to the conclusion that it was not necessary or desirable that he should be re-elected a director, though it might be necessary to retain him in some other capacity. As they did not know what might arise when the proposed fusion took place, they thought it the best policy to keep that vacancy open for the present. There was one thing more to which he would draw their attention: What were they to do with the £10,000? Naturally, he should like to draw a little of it as interest on what he held in the Company; but it appeared to the Directors that it would not be prudent at present to distribute it, for the same reason that in the Edison and Swan Company, where the balance was much larger—about £25,000—it was thought wiser to carry it over for a time. Their litigation in Germany involved the possibility—he was not going to say how remote it was—but it involved the possibility of their being landed in damages, and it would hardly be prudent to be parting with a fund out of which those damages would be fairly met if they arose. He did not want to alarm anybody—he did not attach very overpowering weight to it; still he thought they ought to keep that amount in hand till they knew where they were. If the litigation were put an end to by both parties retiring from it, as it was in France, then they would have that £10,000 undiminished. He could not imagine, from what he knew of the German courts, there was any probability of the damages coming to anything like £10,000; but it was an indefinite amount. Another reason for this was that this Company was an English company, and they were advised that it was forbidden by the law to distribute a dividend where there was a waste in quantity, such as the cost of patent rights, as per last balance-sheet. They had got rid now of that portion of the patent rights which affected a considerable portion of Europe; but there was a certain residuum in Germany, India, the Cape, and some outlying places, to which it was quite impossible to attach, in a concrete form, any apportionment of the £105,000—now reduced to £90,000 by the sale of a portion of those patents in France. They could not say that in Germany, in India, or in some other places the patents were worth £30,000. But while that £90,000 remained in their balance-sheet they were advised that they could not distribute a dividend, and being thus advised they would, of course, be exceedingly rash to attempt to distribute it. What he thought would in any case be a very prudent thing to do was this: these patent rights had a certain term to run, and what they were trying to do in this Company, as well as the Edison and Swan, was to utilise that period in the improvement of the lamp, so as to have the production of the very best article, and in the extension of their connection. They found a going concern, and having a good trade mark was to be comparatively independent of patent rights or protection when the time came for those rights to expire. Then, would it not be wise, if they had, during that term of years which remained, considerable profits, out of those profits to write down the post of that account, so as to start fair when they commenced competition with all mankind four or five years hence, by having that post, the wasting quantity, removed? He thought the law rather shadowy about it, but they had better err on the safe side. He was prepared to recommend the proprietary to do one of two things, or both, or partly one and partly the other. Out of any exuberant profit let them put aside a portion, and also consider whether it would not be a wise thing to do what the courts would allow them to do—reduce their capital. Writing down the capital was a purely theoretical thing. It did not matter to them whether their shares represented £3. 10s. paid-up, £3 paid, or £2. 10s. paid, if the holders of those shares were entitled to all the profit made. It was simply a question whether they should have 5 per cent. on one figure or a larger percentage on a larger figure. It was not as though they were going to dilute their capital, and they would relieve themselves of the embarrassment of having to lock up dividends when they wanted to pay them. He was only throwing out the idea at present. If it were seriously proposed they would have to have an extraordinary meeting of shareholders, and they would then be asked to make up their minds whether it would be a prudent thing to do. He had now said all he had to say, but would be happy to say as much more as any questions might elicit. He moved: "That the report of the Directors and accounts for the year ended September 30, 1888, be received and adopted."

Mr. F. R. Leyland (Deputy-Chairman), seconded the motion, and said he fully concurred in what the Chairman had said: first, as to the desirability of keeping in hand the £10,052 which stood as profit—they had already had to deposit £5,000 in Germany to meet any damages if the case went against them—and also as regarded the desirability of reducing their capital. He thought that latter was a question which would shortly arise and must be dealt with.

The motion was carried unanimously.

Mr. Swan was re-elected as director, Messrs. Quilter, Welton, and Co. were reappointed auditors, and this also having been carried, the proceedings closed.

CITY NOTES.

Brazilian Submarine Telegraph Company.—The traffic receipts for the past week amounted to £5,627.

Eastern Extension Telegraph Company.—A quarterly interim dividend of 2s. 6d. per share has been declared by the Eastern Extension Telegraph Company, Limited, payable on 15th prox.

Western and Brazilian Telegraph Company.—The traffic receipts for the past week, after deducting the fifth of the gross earnings payable to the London Platino-Brazilian Telegraph Company, were £4,695.

Anglo-Portuguese Telephone Company, Limited.—Coupon No. 2 of the six per cent. debentures of this Company, due January 1 next, will be paid, less income-tax, on and after that date by the Alliance Bank, 2, Bartholomew-lane, E.C.

Telephone Company of Austria, Limited.—Coupon No. 6 of the five per cent. debentures of this Company, due January 1 next, will be paid, less income-tax, on and after that date, by Messrs. Martin and Co., 68, Lombard-street, E.C.

Removal of Offices.—The United Electrical Engineering Company, Limited, of 36, Albert-embankment, are removing their offices and showrooms, to 3, Prince's-mansions, Victoria-street, Westminster, the change to take effect as from the beginning of the year.

NEW COMPANIES REGISTERED.

The British Electric Tramways and General Syndicate, Limited.—Registered by J. C. St. A. Angove, 27, Chancery-lane, London, W.C. Capital, £10,000, divided into 2,000 shares, of £5 each. Object: to promote, make, and provide, purchase, acquire, and dispose of railways, tramways and other ways in the United Kingdom, and to equip, maintain and work any of such ways belonging to the Company. The first subscribers are:

	Shares.
J. W. Haynes, 4, Albert-villas, Forest Gate, E.	1
H. D. Poole, 33, Chancery-lane, London, W.C.	1
J. C. St. Angove, 27, Chancery-lane, London, E.C.....	1
E. de Pass, 68, Fleet-street, London, E.C.....	1
J. A. Bunhill, 42, Mildmay-park, N.	1
J. W. Walsh, 81, Gracechurch-street, London, E.C.	1
F. H. Bromwich, 13, Upper Woburn-place, W.C.	1

The first Directors shall be J. W. Haynes and two others to be elected by the shareholders, and shall each hold 10 shares. The remuneration of the Directors is not stated.

PROVISIONAL PATENTS, 1888.

DECEMBER 7.

17,881. **Improvements in metal arms or brackets for telegraph or telephone posts.** John Sidney Crowley, 4, Mansfield-chambers, 17, St. Ann's-square, Manchester.

17,911. **Improvements in apparatus for indicating the period electric lamps are caused to burn.** Alfred Hewlett Fletcher and Samuel Wells Cuttriss, 6, Lord-street, Liverpool.

17,893. **Improvements in fac-simile telegraphic apparatus.** Anthony McKeand Cochrane, 87, St. Vincent-street, Glasgow.

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17,915. **Improvements in the insulating of electrical machines and conductors.** George Rebecca Gibson and Alexander Fraser Macfarlan, 212, St. Vincent-street, Glasgow.

17,918. **Improvements in electrical counting mechanisms.** Francis Edward MacMahon, 24, Southampton-buildings, London, W.C.

17,927. **An electric steering indicator.** Adolph Charles Boursot, 28, Southampton-buildings, Chancery-lane, London, W.C.

17,929. **Improvements relating to the application of electricity to Turkish, hot air, vapor baths, and the like.** Jesse Joseph Wilkinson, 20, High Holborn, London, W.C.

DECEMBER 8.

17,964. **Improvements in electric generators and motors.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, Chancery-lane, London, W.C. (Alfred Miles Taylor, India.)

DECEMBER 10.

17,993. **An improved portable electric lamp.** Auguste Serraillier and George Pulling Armstrong, Suffolk House, Laurence Pountney Hill, Cannon-street, E.C.

18,018. **Improved electric automatic fire-alarm.** Howell Benson Phillips and Wilkinson Mitchell, 22, Southampton-buildings, Chancery-lane, W.C., Middlesex.

18,022. **Improvements in dynamo-electric machines.** Charles Eugen Lancelot Brown, 46, Lincoln's-inn-fields, London, W.C.

DECEMBER 11.

18,035. **Improved apparatus for regulating and measuring electric potentials and currents.** Sir William Thomson, 115, St. Vincent-street, Glasgow.

18,050. **Improvements in motors.** Thomas Dealy, 6, Lord-street, Liverpool.

18,057. **Improvements in cut-out apparatus for electric lamps.** Philip Middleton Justice, 55 and 56, Chancery-lane, Middlesex. (Charles Heisler, United States.) (Complete specification.)

18,091. **Improvements in electro-motors.** William Aldred, 3, Poet's-corner, Westminster, S.W.

DECEMBER 12.

18,116. **Improvements in electrical primary batteries.** Arthur Benjamin Atkinson and Henry Metcalf, Union Chambers, North-street, Brighton.

18,154. **Improvements in and relating to door locks and fastenings, consisting of an electro-magnetic lock connected with an alarum.** Peter Charles Wood, 111, Delaford-road, Rotherhithe, S.E.

DECEMBER 13.

18,187. **Improvements in electric generators and in electro motors.** Moritz Immisch, 52, Chancery-lane, London.

18,220. **Improvements in electricity meters or coulomb meters.** Emile Batault, 68, Fleet-street, London. (Date applied for under Section 103 of the Patents, &c., Act, 1883, 28th July, 1888, being date of application in Belgium.)

18,233. **Improvements relating to duplex electric telegraphs.** Herbert Arnaud Taylor, 45, Southampton-buildings, London.

18,242. **Improvements in electrical apparatus for the transmission of sound.** Robert Henelade Courtenay, 60, Chancery-lane, Holborn, Middlesex.

COMPLETE SPECIFICATIONS ACCEPTED.

JANUARY 6, 1888.

242. **Improvements in electrical measuring instruments.** John Hubert Davies, 23, Andalus-road, Clapham, S.W.

JANUARY 9, 1888.

366. **Improvements in electric arc lamps.** Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London, W.C. (The firm of Siemens and Halske, Germany.)

FEBRUARY 1, 1888.

1525. **Improvements relating to the distribution of electricity.** Louis Edmond Solignac, 35, Southampton-buildings, London.

FEBRUARY 18, 1888.

2449. **Improvements in systems of and mechanism for electric railways.** Orren Allen, 52, Chancery-lane, London, Middlesex.

AUGUST 9, 1888.

11,514. **Electrically-controlled apparatus for checking, extinguishing, and preventing the spread of fire, and for simultaneously giving the alarm.** Thomas Ralph Douse, 166, Fleet-street, London.

SEPTEMBER 19, 1888.

13,529. **Improvements in electric meters.** Anthony Reckenzaun, Gray's-inn-chambers, 20, High Holborn, London, W.C.

NOVEMBER 2, 1888.

15,865. **Improvements in multiple printing telegraph apparatus.** Claude Joseph Munier, 6, Bream's-buildings, London, E.C.

SPECIFICATIONS PUBLISHED.

1887.

15,591. **Ships' compasses.** L. Sirieix. 8d.

15,878A. **Measuring the time during which a current of electricity, &c., is flowing.** V. Popp. 6d.

17,502. **Electricity meters.** G. Hookham. 8d.

1888.

296. **Switches for electric circuits.** T. Parker. 8d.

472. **Treating sewage, &c., by electrolysis.** W. Webster. 8d.

584. **Supplying electric railways, &c., with electricity.** W. L. Madgen. 8d.

1557. **Duplex telegraphy.** F. Jacob. 8d.

4673A. **Switch, &c., for incandescent electric lamps.** P. M. Justice. (Heisler.) 8d.

12,063. **Electrical type writers, &c.** A. J. Boult. (McLaughlin.) 11d.

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12,453. **Hardening and tempering by electricity.** W. P. Thompson. (Diehl.) 8d.

14,492. **Electrical signalling, &c.** J. B. Sutherland. 8d.

14,691. **Telephone central-station apparatus.** T. N. Vail and J. A. Seely. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	101
12 Feb.	1/2	Anglo-American Brush E.L.	4	4¼
12 Feb.	2/0	— fully paid	5	5¼
26 Oct.	7/6	Anglo-American	100	47
26 Oct.	15/0	— Pref.	100	69
12 Feb., 85...	5/0	— Def.	100	15⅝
14 Nov.	5/0	Brazilian Submarine.....	10	13½
14 Nov.	0/4½	Con Telephone & Main ...	1	⅝
10 Aug.	9/0	Cuba	10	14½
10 Aug.	10/0	— 10% Pref.	10	19
12 Oct.	2/0	Direct Spanish	5	4½
12 Oct.	5/0	— 10% Pref.	5	10
26 Oct.	2/0	Direct United States	20	9½
12 Oct.	2/6	Eastern	10	12¼
12 Oct.	3/0	— 6% Pref.	10	15
1 Aug.	5%	— 5%, 1899	100	109
26 Oct.	4%	— 4% Deb. Stock	100	106
12 Oct.	2/6	Eastern Extension, Australasia & China.....	10	12⅝
1 Aug.	6%	— 6% Deb., 1891	100	106
2 July	5%	— 5% Deb., 1900	100	106
2 Nov.	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	106
28 Mar.	8/8	German Union	10	9½
12 Oct.	1/0	Globe Telegraph Trust.....	10	6⅞
12 Oct.	3/0	— 6% Pref.	10	14½
30 April	5/0	Great Northern.....	10	14⅝
1 March.....	5%	Gt. Northern 5% Deb., '83.	100	106
27 July	10/0	India Rubber, G. P. & Tel.	10	17½
26 Oct.	12/6	Indo-European	25	40
14 Nov.	2/6	London Platino-Brazilian...	10	8
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	½
26 April	4/0	Reuter's	8	7½
.....	...	Swan United	3½	2⅝
10 Aug.	13½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust ...	100	97
12 July	12/0	Telegraph Construction ...	12	40½
2 July	6/0	— 6%, 1889	100	105
29 Nov.	5/0	United Telephone	5	14
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	99
12 July	4/0	West Coast of America ...	10	9½
30 June	8%	— 8% Debs.	100	125
26 Oct.	6/0	Western and Brazilian.....	15	13½
26 Oct.	6/	— Preferred	7½	6½
11 May	2/1½	— Deferred.....	7½	6⅜
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
.....	...	West India and Panama ...	10	1⅜
29 Nov.	12/0	— 6% 1st Pref.	10	11⅜
18 May, '80...	...	— 6% 2nd Pref.	10	12
2 Nov.	7%	West Union of U.S.	$1,000	122
1 Mar.	6%	— 6% Sterling	100	10a

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NOTES.

France.—The town of Nimes is to be lighted by electric light. A concession has been given for eighteen years.

"The Telephone."—A new electrical journal under this title, and devoted specially to telephone interests, will be issued fortnightly after the 1st of January next, published by Messrs. Wm. Clowes and Sons, Charing Cross.

Military Portable Telephone.—The Italian Minister of War has made a series of experiments with a small portable magnetic telephone, submitted by Signor Nigra. The trials were very successful over a distance of twenty miles.

Electric Launch Building in Scotland.—Mr. James Adam, ship builder, of Gourock, N.B., has contracted for a new electric launch to be built from the designs of Mr. G. L. Watson. She will be the first of her kind constructed in Gourock.

Woolwich Arsenal.—We hear that the electric lighting of the new central offices at Woolwich Arsenal has been entrusted to Messrs. Drake and Gorham. The work is already well advanced, and the contractors hope to complete early in January.

Barnet.—The electric light at Barnet, when we saw it the other night, was working very well, and the lights all alight and well up to power. A large and brilliant sunbeam lamp is now established and gives a fine light at the junction of the two main roads in the town.

Brussels Exhibition.—We notice that the *Chronique des Travaux Publics* speaks in very high terms of M. Bandsept, who, it will be remembered, superintended the electric lighting department of the Brussels Exhibition, and congratulates him on the efficiency of the lighting and the absence of accident or hitch.

Galway.—The proposal to introduce electric light into Galway, which we have mentioned, resulted in a warm discussion at the Council meeting recently. The supporters of the gas company were very fierce in their denunciations of the intruding light, and the meeting eventually broke up with much "gesticulating with the fists."

Telephone Company.—*La Cote Libre* announces that the Brussels firm of Messrs. Mourlon Frères is to be transformed into a company, under the name of the International Telephone and Telegraph Company. The capital is fixed at a million francs, which it regards as comparatively small considering the standing of the house.

A Good Chance.—Preston, in Lancashire, would be a good town to introduce electric light into, we should imagine. It is close upon the Wigan coalfields. Gas, it appears, is some 6d. or 9d. per 1,000 dearer than in London, and the gas company is one of the most profitable in existence. No wonder, with these advantages. A little electric competition would do them—and the public—good.

Cheap Fuel.—The Suburban Railway Company at Scranton, Pennsylvania, fitted with the Sprague system, is exceptionally situated as regards cheap fuel, having made long contracts for the supply of "culm" (anthracite waste) at a cost of 5d. per ton at the pit. They have been using this fuel for over a year, says a correspondent of the *Street Railway Journal*, and find that it has at least 75 per cent. of the steam-producing capacity of the best anthracite coal.

Wearing of Commutators.—A system of regulation of dynamo brushes has been proposed to prevent undue wearing of the commutator sections. In this, instead of the brushes being fixed in position, a to-and-fro movement is given to the brush-holders by means of a slow-moving eccentric arm geared to the axle. This arrangement moves the brushes regularly backwards and forwards over the length of the commutator, and the wearing away of the metal in furrows is thus obviated.

Increase of Resistance on Fusing.—C. L. Weber (*Ann. Wiedemann*, xxxiv., p. 576) has made some interesting observations on the variation of the resistance of alloys of tin-lead and tin-bismuth at their period of fusion. A considerable and rapid increase of resistance is observed as the fusing-point is reached, and it is the more marked the simpler the composition of the alloys. Pb_2Sn behaves like pure tin. The tin-bismuth alloys are very irregular, for the specific resistance of bismuth falls as the point of fusion is reached.

Phosphor-Tin Wire Fuses.—It was at one time the usual habit to use lead wire for the fusible wire in safety catches, and later this has given place to the wire which has come into almost universal favour for this purpose. The use of phosphor-tin wire has been recommended for the fusible wire, as being preferable to either, being inoxidisable, and of a low and constant fusing point. The wire is to be obtained of M. Lazar Weiler, of Tours, France, and we have no doubt English makers will supply it, if it prove practically beneficial.

Railway Station Indicator.—The use of an indicator to show travellers the name of the next station has often been proposed. A system of this kind, worked by electricity, is being tested practically upon one of the smaller French lines. A telegraphic dial in the guard's van, with the names of the stations inscribed thereon, is in communication with similar dials in all the carriages. The guard puts his needle to the name of the station at which the next stop is made, and all the needles assume the same position throughout the train.

Walbrook.—At the Walbrook wardmote, held at Cannon-street Hotel on Friday, Mr. White, in returning thanks for his re-election, said the Corporation had now in hand the completion of their markets. In the course of next year they would lay out £20,000 at Farringdon-street in making a fruit and vegetable market. Besides that, Billingsgate Market was being extended and improved. The Common Council was also considering the question of the improved lighting of their streets, and the electric light was being carefully watched by the Common Council.

Tin Pickling.—We hear of a small and powerful syndicate which has possessed itself of a new process of tin-plating, or "tin-pickling," as it is termed, in which electricity plays an important part The saving over the usual process is said to be something like 60 per cent. Works have been established, we believe, somewhere in the neighbourhood of Deptford, and several contracts have been carried out at extremely remunerative prices. It is expected that, if all expectations are carried out, this will have rather an important effect upon the tin trade.

Cardew's Patents.—We are informed that Messrs. Drake and Gorham, of 2, Prince's-mansions, Victoria-street, have purchased the whole of the electrical patents held by Captain Cardew, R.E., the only exception being his measuring instrument in America. These patents include not only the well-known Cardew voltmeter, but other devices in connection with central station lighting, which are

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likely to be in large demand. They are not proposing to manufacture the apparatus themselves, but to licence a few firms of good standing to manufacture under royalty.

Electric Light in Egypt.—A limited company, says the *Moniteur Industriel*, obtained some time ago from the Egyptian Government the concession for the installation of the electric light in the principal towns of Egypt. The *concessionaires* having applied to the Government for definite permission to begin the work, the fiscal committee are discussing the matter with a view to settle the question. Meanwhile, the Egyptian Gas Company, fearing the concurrence of the authorities, and no doubt foreseeing heavy losses if the electric light gets a hold, have considerably reduced their tariff.

Prepayment Meters.—An addition to the ordinary gas-meter is being introduced by Mr. R. W. Brownhill, of Aston, near Birmingham, by which the penny automatic action is combined with the meter, and small consumers can purchase six or eight hours' supply by the insertion of "one penny in the slot." The light diminishes a quarter of an hour before cutting off. By this means it is expected that thousands of small consumers will be able to have the light. Possibly the hint may be useful to electrical supply companies when the demand for light or power becomes an extensive item of supply, and desire is manifested for extension of custom.

St. James's Central Station.—Many of the ratepayers in the district of Mason's Yard, where the St. James's electric lighting station is being erected, are greatly exercised by the supposed probable nuisance and injury to property caused by the machinery, and by the present noise caused by work being carried on night and day. A deputation waited on the Vestry at the last meeting, and were advised to consult a solicitor. The deputation was not satisfied, and refused to retire when called upon to do so, and a scene nearly ensued. Mr. Keevil afterwards called the attention of the Vestry to the matter, and moved that the matter should be referred to a select committee, but the motion was lost.

Overhead Wires.—The question of overhead wires is likely to become of chronic importance with all local authorities owing to the revival of electric lighting schemes. Birmingham is now considering the question, and some correspondence on the subject has been carried on in the *Birmingham Post*. We would suggest to our contemporary, and to those interested in the subject, that the solution of the problem seems to lie in the direction indicated by Lord Crawford and Balcarres. He would use overhead wires as pioneer wires only, and thus of a more or less temporary character, to be replaced by underground wires before the expiration of a period agreed upon by the electric light companies and the local authorities.

Almanac.—We have received from the Anglo-American Brush Corporation an exceedingly tasteful and beautifully-printed almanac for 1889 for electrical customers to hang in their halls, showing the genius of electric lighting holding an arc lamp (presumably a Brush lamp), illuminating the whole City of London, which lies in an artistic bird's-eye view below—omen of future extension. Useful electric memoranda and data fill up the corners not taken up with the scroll, containing days of the year. A handbill, showing the specialities of the Brush Corporation, accompanies this, illustrating the Suez Canal lighting, Raworth's combined plant, Mordey's alternator, Brush dynamos, electric trams in action, diving lamps, and lamps for collieries.

Theatre Lighting in Paris.—The Chief Commission of Theatres of Paris has recently presented to the Municipal Council a report upon the way in which the measures for security ordered by the Council have been carried out in the theatres of Paris. According to this report, the electric light is now almost universally adopted; those theatres which have not adopted the light are waiting solely for the time when permission has been obtained to connect the wires with their premises. The Commission state that they have decided to exact the fulfilment of the conditions that all may be finished before the end of the winter, so as to guard as effectually as is in their power against the occurrence of any catastrophe which would spoil the success of the Exhibition of 1889.

E.P.S. Central Stations.—The Electrical Power Storage Company have applied for provisional orders for the parishes of St. Martin's-in-the-Field, the Strand, and Paddington, and are now seeking the assistance of the local authorities. It is understood that the company in this undertaking are backed up with a syndicate with ample capital. The system to be employed will be the "E.P.S. distribution system," in which a large central station, with engines and dynamos, will distribute the current to subsidiary stations of storage batteries. For a 10,000-light station these subsidiary stations would serve an average of 1,000 lights each, and for a 20,000-light station 2,500 lights each; but will vary in proportion to the size and population of the district.

Another Chance for Electric Traction.—A sub-railway is proposed from St. James's-street to Holborn-circus. The Works Committee recommend the St. James's Vestry to oppose the project, but Mr. Beal said he hoped the Vestry would do nothing to obstruct the formation of a great and much-needed public improvement. Sub-railways would have to be made sooner or later, and extended to a much greater length than was proposed by this scheme. The enormous annual increase in the population of London, with the resulting increase of traffic, could not be ignored. He moved that the whole subject be sent back to the committee for further consideration and report. Mr. Dixey seconded, and the motion was carried. We should advise our electric traction engineers to keep an eye upon this scheme. No doubt their services will eventually be called into requisition if the scheme gets through.

Beattie Zincs.—If anything approaching to what is stated about the zinc plates invented and manufactured by Mr. John Beattie, of Fall River, Mass., U.S., is true, there ought to be a good trade in these elements in England. Some four years ago, it is said, he made experiments by which zinc and mercury could be combined in the crucible. The Beattie zincs are now on the market, and tests made state that they exhibit an average of 2 per cent. excess in E.M.F. over ordinary commercial zincs, an average of reduction of 20 to 30 per cent. in internal resistance, and a gain of 18 per cent. in economy of consumption. It was also found that the use of the Beattie zincs delayed polarisation, and that the cells containing them recuperated after short circuit much more rapidly than did the cells containing commercial zincs. These are startling results. We wonder whether they can be repeated by our electricians.

Catalogue.—We have received the fourth edition of the catalogue of the Electric Apparatus Company, 4, Charing-cross, W.C., in which a large number of useful electrical fittings find place. The "Trafalgar" dynamo, illustrated, is evidently of a good type of mechanical construction, and

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is shown in conjunction with vertical and high-speed engines. A list of these dynamos is given from 10 lamps at 35 volts up to 870 at 115 volts. Small dynamos for workshop and experimental use are made a feature. The "Trafalgar" arc lamp is another speciality, said to be of very simple construction and design, and weighing only 8lb., with push feed mechanism—not gravity feed; no clockwork, gearing, spindles, brakes or clutches are used. These lamps are made to work with five amperes and up to 20, and the price is moderate. Schuckert's, Statter's, and Miller's measuring instruments are included in the catalogue, with other instruments. Small motors and portable pocket accumulators are a speciality to which some attention is given. The list of technical terms given will be useful to inoculate persons receiving the catalogue with the terms in common use, but such a statement as that "the loss of E.M.F. on conductors can be reckoned to be about 2·5 volts for every 100 yards" wants some modification. Terminals, wire, flexible cords, switches, cut-outs, and holders are all to be obtained at the premises of this company, and we should imagine a central position such as this would be very convenient for supply of electrical sundries.

Ghent.—The arrangements for lighting the docks at Ghent have been tested with satisfactory results. The lamps will not, however, come into regular use until the 1st January, the date on which the town has undertaken to begin the service. The new light will be of the greatest utility to the owners of steamers. Hitherto loading and unloading has been carried on by the light of oil or gas with great difficulty, but henceforth these operations will be greatly expedited. The prime motor and dynamo are placed in the building containing the hydraulic machinery for actuating the lifts, etc., in the docks and warehouses. The former is a Parson's steam turbine, having a speed of 10,000 revolutions. There are eight arc lamps, Dulait's patent, of 1,200 c.p., hung from iron posts of 10 metres in height, and several portable incandescent lamps enclosed in lanterns, which can be used in the holds of vessels. These lamps have special leads from the arc lamp-posts, and can be hoisted out of the way when the ship has discharged her cargo. The installation is so arranged that the engine-driver can see the whole of the lamps, etc., without leaving the machine-room. On the other hand, the public, or the dockyard employés, can extinguish or switch in any of the lamps without warning the engine-driver. This installation was very quickly put up, being only begun on the 6th inst., and by the following Monday the light was going. The work was entrusted to the Société d'Electricité et Hydraulique, of Charleroi. In this connection we may add that M. Dulait is the hydraulic engineer who designed the apparatus for working the Muide bridge. His latest work merits a word of praise.

The Julien Patent.—We are in receipt of information with reference to a decision which has just been arrived at in the United States Patent Office, which may have important results over the manufacture of storage batteries. The point at issue is between Mr. Julien, who holds a patent for an inoxidisable alloy for support plates of accumulators, and the Electrical Accumulator Company of New York, who are the owners in America of the Faure-Sellon-Volckmar patents. The latter company, no doubt with a view of testing the validity of Mr. Julien's patent, filed an application in the United States Patent Office some time ago for a patent, claiming, among other things, an alloy containing lead and antimony for a support plate in a secondary battery. The Julien Electric Company claimed this patent. Much expert evidence was offered on both sides; Prof. Morton, Mr. Reckenzaun, and Mr. Madden testified on behalf of the Electrical Accumulator Company, and Prof. Barker, Dr. Van der Weyde, and Mr. Salom testified on behalf of the Julien Electric Company. The case was then argued before the Commissioner of Patents by able counsel on both sides. It was proved on behalf of the Julien Electric Company, and it has been admitted by the examiner in his opinion, that while an alloy of lead and antimony has serious disadvantages as a support plate by reason of the crystalline structure of the metal making it liable to oxidation and consequent disintegration, yet the presence of mercury removes this defect, and makes the alloy homogeneous and practically inoxidisable. The Commissioner, after due consideration, decided in favour of the Julien Electric Company, holding that an alloy of lead and antimony had no novelty, but that an alloy of lead, antimony, and mercury, as claimed by Mr. Julien, has specific advantages and novelty. This decision is regarded as an important triumph by the Julien Electric Company, and will be of considerable interest to makers of accumulators.

Paris International Congress.—The committee of organisation of the International Congress of Electricians met on the 17th inst. and carried several important resolutions for the regulation of the congress, among which the following are the principal: The congress will be held for a period of eight days. Members of the congress will consist of persons who send in their names to the President of the Commission of Organisation before the opening of the session, or who subscribe during the session, upon payment of a minimum subscription of 20 francs. The first meeting will be occupied with the constitution of its council; the council will receive papers, fix upon the order of proceedings, regulate the discussion, and edit the reports. Members only will be allowed to assist, read papers, and take part in the discussions. The reports will be printed and distributed to all members. A complete report of the proceedings will be afterwards published, under the care of the council, each member to be entitled to a copy. The programme we have already given is not meant to be exclusive, but is adopted solely to direct attention to those questions more immediately interesting. The following questions will be given predominance: Practical measurement of electrical energy in all its forms, current measure in absolute values with standards for easy reproduction; electric meters for continuous and alternate currents; practical estimation of lighting power; definition of the constants of a dynamo from the commercial point of view, etc. They express the hope that all scientists and technical men who have contributed to the success of applied electricity, and all persons who interest themselves in this new branch of human activity, will respond heartily to their appeal and help to give to the meeting the importance and authority of the previous congress. All communications relative to the congress should be addressed to M. Mascart, president de la Commission d'Organisation, 176, Rue de l'Université, Paris.

Lyric Theatre.—The electric fittings at the Lyric Theatre were made by Messrs. Benham and Froud, Limited, of Chandos Metal Works, Charing Cross. The principal electrolier, illuminating the whole of auditorium, was carried out from a suggestion of the proprietor of the theatre, Mr. Leslie, and represents an inverted bouquet of corn, barley, and poppies in prodigal confusion. The

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upper portion is a curved cone of *repoussé* work, representing the stalks bound together with wisps of straw, and ornamented with scroll work. Below this is a band around which 20 lights are placed; from these, 13 stalks descend, upon each of which are 10 incandescent lamps inside embossed poppies, and ornamented with a corresponding number of wheat ears. The work is executed in copper and brass, electro-gilded, frosted and partly burnished, the poppies being of frosted silver inside for effect, and for enhancing the light. This electrolier is about 8ft. high and 6ft. diameter, and the effect, with its 150 lights, is brilliantly fine. The grand saloon is at present lighted by two girandoles, forming part of the overmantel, embossed in Renaissance style, with figures of boys with musical instruments introduced. From about the centre of these plaques spring three massive chased dragons, and holding in their mouths three branches, each with a lamp in silvered cup, 18 lights in all. These girandoles are also electro-gilded and burnished. The royal room is lighted by four brackets, each with five lights, delicately treated in the Adams style, and executed in frosted and burnished silvered work. The grand entrance has six four-light brackets, and the crush room two of the same design, and two half coronas each with six lights, made in combinations of polished and frosted brass, and designed in harmony with the Pompeian decoration of these two apartments. The fittings for saloon, royal rooms, and Pompeian rooms have been specially designed by Owen W. Davis, Esq., and the whole work carried out under the direct supervision of Mr. R. W. Laws, director of the art department of Messrs. Benham and Froude.

Electrolysis of Magnesium Chloride.—In the *Proceedings* of the Chemical Society the following abstract appears of a paper by C. F. Cross and E. J. Bevan, on "Some New Compounds of Magnesia with the Halogens: A Contribution to the Study of the Electrolysis of Magnesium Chloride Solution." Their observations on the electrolysis of magnesium chloride in aqueous solution, which is now a process of preparing bleaching solutions on the large scale, had previously made the authors aware that the decomposition was attended by interactions *not* to be explained on the view commonly held—viz., that the ions are magnesium and chlorine, which by secondary interactions give rise to magnesia and hypochlorous acid. With the view of elucidating the actual mechanism of the electrolysis, the authors have studied in the first instance the phenomena at the cathode. The white substance separated under the condition that the solution is not kept in circulation, is not magnesia (hydrate), but a chloroxygen-compound of magnesium, in which the ratio of Cl to total oxidising power expressed as Cl is approximately 1 : 2. It may be regarded, therefore, as a magnesium hypochlorite. It is worthy of note that the percentage weight of "total oxidising Cl" lies between 30 and 35, calculated on the anhydrous substance. The compounds described were analysed in the freshly prepared and hydrated condition. They differ from the normal magnesium hypochlorite not only in being insoluble, but also in point of their stability. Similar compounds were obtained on electrolysing solutions of magnesium bromide and magnesium iodide, though in the case of the latter the ratio—total oxidising iodine : iodine as silver iodine is considerably less than 2—viz., approximately 6 : 5. Nevertheless, the compound decomposes ammonia with evolution of nitrogen, and is in all its properties rather a compound than a mixture of iodine with magnesia. The authors are engaged in studying the phenomena to be observed at the anode during the electrolysis in question, and the composition of the resulting solution in regard to the whole of the chloroxygen-compounds, of which there appear to be at least two.

Practical Work in the Technical Institute.—H. C. Spaulding, a graduate of the American Institute of Technology, in a recent paper read before the Electric Club, gives a graphic account of how laboratory work and boiler and fuel tests are conducted at the institute, a kind of training that would tend to enable a man to tackle really useful and practical work. For knowledge thus gained he would be willingly paid on his entrance on the world's work, instead of being laughed at for display of book knowledge and mathematics, which are practically useful only when superposed on such training. They are taught to *do* the work, and not only how to do it. "*The young men*," he says, "appear in flannel shirts and leather aprons ready for two or three hours at the anvil or forge, or prepared for work in the mining laboratory. The mode of operation is rather different from that in vogue in some institutions where the assistants do all the work and the students look on, making comments and taking notes of the operations. In the institute every man is obliged to go into matters for himself, dirt and such minor disadvantages being considered of no importance. I recall with pleasure, not entirely unmixed, however, with other sentiments, several cold winter mornings when, with other poor wretches, I reported for duty at the institute buildings at 6 a.m. Seven or eight of us were on for a boiler test, which necessitates being on hand at this unearthly hour. In these boiler tests different stations are alloted to each student, as, for instance, weighing the coal, weighing the feed water, weighing ashes, etc., are recorded every five minutes during a ten-hour run, and calorimeter tests are made two or three times during the day to determine the quality of the steam. Great care is taken that the conditions of the boiler at beginning and ending the tests shall be as nearly similar as possible. Toward this end the fires are drawn at about five minutes before the time of beginning and the steam pressure brought to the average point, the level of the water being also noted. At the given signal a known quantity of fuel is put on the grate and the fire started. At the end of the test, the boiler being as nearly as possible in the same condition as above, the fires are drawn again, and the exact weight of the fuel thus removed deducted from that used in firing during the day. I think this method of carrying on the test will, for the actual value of its results, compare favourably with that recently proposed by a prominent educational gentleman in New England, who advocated using a small boiler upon platform scales for this purpose. Work has been done in the electrical laboratory, including electrical and mechanical tests of some different makes of motors, also upon the efficiency of the Westinghouse converter. A new method has been used for testing the converters, which requires no measurements not obtainable with an alternating current. Tests have been made upon incandescent lamps of different makes, including the customary ones, upon life and efficiency, and also upon the rise of candle power with increased voltage, and it is expected that the results of this latter line of work will be shortly in condition for publication. The specific inductive capacity of different materials has also been investigated, with some very curious results. Different makes of storage batteries have also been practically tested and compared."

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ELECTRIC LIGHT AT BRAEHEAD HOUSE, DUMBARTON.

We had the pleasure of visiting Braehead, the residence of A. Denny, Esq., a few days ago in order to see the electric light, which has now, so far as light is concerned, entirely taken the place of gas, candles, and lamps in that house. We began by visiting the engine-room, and there we found a 2 h.p. Otto gas-engine driving a shunt-wound dynamo working at 1,000 revolutions, supplied by Messrs. Paterson and Cooper. The engine-room is divided by a wood and glass partition into engine-room proper and accumulator-room.

In the accumulator-room we found 26 E.P S. 1888 15 L type cells. The controlling switchboard is in the engine-room, placed conveniently over the dynamo. It is of neat design and simple, and was supplied by Messrs. Muir, Mavor, and Coulson. The engine-room is situated in a cellar underneath the drawing-room, and is a model of cleanliness and neatness, well lighted and ventilated.

We then proceeded to visit the various apartments. The drawing-room is lighted by means of ornamental brass side brackets, each bracket fitted with two 10 c.p. lamps. There are four of these brackets, making a total of eight lights. The lamps are frosted and fitted with venetian glass shades, which gives a most pleasing effect. There is also a piano light, supplied by Faraday, of London, which, while lighting the music, is so shaded that the light does not strike the eyes of the performer.

Turning to the dining-room, we found the only fixed lights are two over the sideboard, which are used for giving a general illumination; but for the dining-table, a crystal oil lamp, which was in use before the introduction of the electric light, has been converted into an electric one, and is fitted with a 50 c.p. lamp. The leads are taken up underneath the table, and, by means of flexible leads and plugs, connections are made to two brass plates sunk into the table. The lamp has corresponding pins in the base, and holes being made to correspond in the table-cloth, the lamp is slipped into the sockets. Mr. Denny informed us that this gives not the slightest trouble, and we can testify to the fact that it gave the table a beautiful appearance—the lamp being covered with a yellow silk shade.

The library is fitted with one fixed light near the book-case, and two portable reading lamps, one at either side of the fireplace, which seemed eminently well suited for a comfortable after-dinner read beside the fire.

The lobby is lighted by a three-branch brass pendant of chaste appearance. Mr. Denny informed us that this was simply the old gas pendant with the brackets turned down instead of up, as in the case of gas. In fact, many of the fittings throughout the house are treated in this way.

In the bedrooms there is a very neat arrangement. On the dressing-table, on each side of the mirror, there stand tall brass lamps surmounted with white globes, in which is the electric light. This gives a splendid light for dressing, more especially for ladies, and it is so arranged that the dressing-table can be at any time removed by simply pulling out a plug attached to a flexible lead. For each bed there is also fixed a lamp with switch arranged conveniently within reach of the hand, so that those who wish to indulge in the pernicious practice of reading in bed may do so without the danger of fire, and without the trouble of rising to turn out the gas, or even exerting themselves so far as to blow out the candle. In fact, all through the house we could clearly see that every detail had been most carefully thought out and arranged after thorough consideration. The light is fitted throughout the entire house, not only in the public rooms and bedrooms, but also in the back premises, even down to the washing-house.

Mr. Denny informed us that he is perfectly satisfied with he light, and finds it of the very greatest convenience.

Owing to the house being an old one, and the rooms small, and low in the ceiling, it was impossible to sit with any degree of comfort in the drawing-room with the gas alight. The introduction of electricity has led to greater purity of atmosphere, lessening the tendency to heaviness and drowsiness. The actual cost of the light has not been ascertained. There are in all 54 lights, two 50 c.p., 18 20 c.p., and the remainder 10 c.p.

The work of erecting and running the leads, etc., was entirely carried out by the electrical staff of the Leven ship-yard, and the wiring is very neatly carried out—in fact, so neatly that, while on examination it was found that all the casings containing the leads are easily accessible, it is difficult to detect them at first sight, nor are they found in the least objectionable.

RULES AND REGULATIONS FOR OVERHEAD CONDUCTORS FOR ELECTRIC LIGHT AND POWER.

We (*Electrical World*) publish below the complete rules and regulations just issued by the New York Board of Electrical Control:

I. No two lines of poles bearing conductors of a like class shall be erected on any street or avenue.

II. No two lines of poles shall be erected on the same side of any street or avenue.

III. Poles shall be set in the sidewalk 12in. from the outside of kerb, and no pole shall be placed within 10ft. of any lamp-post or other pole, except at street corners where necessary in order to support wires running on the cross street.

IV. All poles now standing, or to be hereafter erected, shall be branded or stamped with the initials of the company owning them, at a point not less than 5ft. nor more than 7ft. from the street surface; and when a pole is occupied by wires belonging to more than one company, each group of cross-arms, or where necessary the support of a single wire of different ownership, must be distin guished by some characteristic paint, mark, or fastening.

V. Electric light lamp-posts shall be in accordance with the plan adopted by the board.

VI. All poles erected for the purpose of carrying lines of more than two electric light or power wires shall be at least 45ft. high, uniform in size, straight and painted from top to bottom—a very dark colour from the sidewalk to a point 8ft. high, and a dark green colour above that.

VII. All poles for carrying not more than two electric light wires shall be 25ft. high, straight, uniform in size, and painted from top to bottom—a very dark colour from the sidewalk to a point 8ft. high, and a dark green colour above that.

VIII. Cross-arms shall be uniform in length, strengthened by braces, and painted the same colour as the poles; the cross-arms of each company being distinguished by some characteristic mark.

IX. Each line of poles must be run on one side of the street only, except when absolutely necessary to change to the other side; but this may only be done by the permission of the board or of its engineer or expert.

X. Electric light conductors must not be placed upon fixtures erected or maintained for supporting wires of the other class—namely, those for signalling—except by permission of the board.

XI. Poles shall be uniformly spaced, and about 60 to the mile. This requires on the short city blocks of 260ft., alternately three and two poles to the block.

XII. All conductors shall be secured to insulating fastenings, and covered with an insulation which is water-proof on the outside and not easily worn by abrasion. Whenever the insulation becomes impaired, it must be renewed immediately.

XIII. No wire shall be stretched within four inches of any pole, building or other object without being attached to it and insulated therefrom.

XIV. Every wire must be distinguished by a number plainly marked on each cross-arm under the insulator.

XV. No unused loops from electric light circuits shall be allowed to remain after lamps are taken away, except in cases where it is positively known that the lamp will be required again within three months, and where there is no underground conduit for that class of circuits.

XVI. All arc lamps must be so placed as to leave a space underneath of nine (9) feet clear between lamp and sidewalk.

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XVII. All wires must be stretched tightly and fastened to glass or porcelain insulators, approved by the expert, with a strap of the same kind of wire.

XVIII. All connections with lines of electric light conductors shall be made at right angles to the same; and connections to buildings shall be run straight across to the building and then down the front of the building.

XIX. All joints must be as well insulated as the conductors, and the insulation of joints shall be maintained.

XX. Every line entering a building shall be controlled by a cut-off, placed near the entrance, in sight, and easily accessible.

XXI. No wires shall hang within 20ft. of the pavement at the lowest point of sag between supports.

XXII. In the construction of lines the insulation to be used must be approved by the expert of the board in writing, and the insulation resistance must be maintained in accordance with a standard to be not less than $\frac{1}{10}$ megohm per mile per 100 volts. And under no circumstances shall underwriters' wire be used.

XXIII. All circuits must be tested every hour, and when a ground comes on, effort must be made to remove it at once. Failing in this, the current must be discontinued until the insulation is restored.

XXIV. The insulation must be preserved throughout the entire circuit, and if any portion of a lamp or fixture is a part of the circuit and can be touched, it must be insulated.

XXV. All conductors shall have a resistance uniformly distributed of not more than 30 ohms per mile per ampere, and proportionately less for heavier currents.

XXVI. All existing regulations of the local authorities in regard to the placing of poles and stringing of wires are to continue in force, except when in conflict with these rules, and the rules and regulations of the New York Board of Fire Underwriters must be strictly observed.

XXVII. The violation of any of the rules and regulations of the board shall operate *ipso facto* as a revocation of the permit held by the company or person guilty such violation.

XXVIII. Whenever hereafter any company shall be permitted by this board or its successors to erect posts or poles, or other fixtures bearing lamps or other devices, for the purpose of lighting by electricity the streets, avenues, highways, parks, or public places of the city, the said permission shall be granted only subject to the following provisions, and the same is hereby expressly made a condition of the said permits. At any time when, by action of the city authorities, the contract for lighting any such street or other public place shall be given to another company, the company erecting said lamp-posts shall, on tender of the first cost therefore, yield possession and ownership of the same to the said other company obtaining the new contract, except in cases where the company owning the lamp-posts prefers to remove them.

XXIX. All broken and "dead" wires, and all wires, poles, and fixtures not actually in use—subject to Rule XV. —must be removed from the streets, avenues, and highways of the city. When an old pole is taken down it must be removed from the streets the same day. New poles must not be brought upon any street more than two days in advance of their erection. Any pole that shall lie on any street more than two days shall be removed by the Bureau of Incumbrances of the Department of Public Works, at the expense of the party owning it.

XXX. From and after January 1, 1889, no company shall do business of arc electric lighting in the City of New York without a certificate of the board, granted on the recommendation and after inspection by the expert of the board, to the effect that its lines comply with all the rules and regulations of the board, and that its plant is in proper condition for the doing of its business. The force of the certificate to continue until changes are made, of which the board must be notified and approve, or so long as the plant and conductors remain in the same condition as when inspected.

XXXI. Every lineman must wear a badge in a conspicuous place, giving his number, and the name of the company by whom he is employed.

XXXII. All permits of the board for overhead wires and fixtures are granted only pending the providing of underground accommodations in the neighbourhood of the street or avenue for which the permit is granted.

XXXIII. Any member or officer of the board, and every inspector employed by it, as well as every member of the police force of the city, shall be entitled to examine permits under which work of any kind is being done.

XXXIV. No permit shall be granted for the erection of any overhead structure nor for the renewing of any lines already existing in any street, avenue, or highway in which underground accommodations for the service have been provided, or are being provided.

XXXV. Every line, pole, fixture, etc., must be kept in thorough order, repair, and conformity with these rules and specifications, upon penalty of forfeiture of all permits granted to the owner by this board. But the general permit under which these repairs are to be made does not cover the erection in any street, avenue or highway of any new poles or other similar fixtures, and has absolutely no reference whatever to lines which have been ordered underground by the board, and which the mayor has been requested to remove. In the case of such lines, where notice has been given that underground accommodations have been provided, and the ninety days of notice required by law have elapsed, and the mayor has been requested to remove the same, companies owning or operating said lines are not authorised to make any repairs or connections or to go upon the poles bearing such lines for any purpose whatever, except to remove the said lines of electrical conductors in conformity with the directions of the board. Any deviation from this rule requires a resolution passed at a regular meeting of the board, attested by the secretary.

XXXVI. Every company or person erecting poles, wires, or fixtures must make and leave, at least once each week, at the office of the board, such records of the fixtures, etc., which they are erecting, and of all of the same that they have in use, as are required by the engineer and the electrical expert of the board, and in such form as shall be prescribed by them.

XXXVII. The companies or persons owning or controlling poles in any street or avenue, erected under permits of this board or the Board of Electrical Subways, shall allow the same to be used by other companies or persons operating conductors for similar electrical service when authorised so to do by the board, on tender of proper compensation, to be determined by agreement between the parties interested. In default of such an agreement the amount of such compensation shall be determined by the board. This rule imports a contract on the part of each company or person owning or controlling the poles on any street or avenue, not only with the board, but also with each company or person who shall under its terms be qualified to demand the privileges it confers to permit this joint use of poles. And in accepting any permit the applicant thereby binds himself to this agreement.

ELECTRICITY IN OUR HOMES AND WORKSHOPS.

Last Friday, an extremely interesting and able popular lecture was given by Mr. Paris, of the firm of Laurence, Paris, and Scott, in the lecture-hall of the Church of England Young Men's Society, Norwich. The lecture was enthusiastically applauded, the exhibition and working of the various electrical apparatus finding great favour with the audience. In the manipulation of the apparatus the lecturer was assisted by Mr. Scott.

After dealing with the advance of electricity in other countries, Mr. Paris described the progress during the last eighteen months in England, and referred to the establishment of the Deptford station for the supply of a million or so lights. Endeavours are being made —as by the lecturer's firm at Norwich—to establish central stations in various towns for supply of light, but the electric supply would also furnish power for machines to be used at home. Motive power for small industries carried on in the home can be supplied for 60 hours at 2s. 6d. per week. When there becomes a great demand for such power it can be supplied at a lower figure.

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But even for 2s. 6d. per week an operative who has a machine to which to apply the power, ought to find the outlay remunerative. The lecturer then explained the production of electric light, showed the transferring of a lamp from one part of the room to another, and dealt fully with the usual conviction of the public that electric light was dangerous from shocks—showing by touching the two poles that nothing but a slight "pins and needles'" effect was felt—and showed the working of the magnetic cut-outs patented by his firm. The structure of the incandescent lamp was explained, and the use of high candle-power incandescent lamps was shown. Dealing next with electric power, Mr. Paris considered this to be more important commercially than the electric light. The distribution of power would be productive in the future of the greater part of the income of the central station. But the commercial revolution this would mean is yet practically unrealised. When Defoe visited Norwich, early in the last century, he found most of the people employed at looms in their own houses. The introduction of steam-power brought about the factory system with its congregation of operatives. But now that power can be transmitted in the quantities required by means of electricity, there is no reason why operatives should not revert to the old and more healthy system of working at home instead of in factories in a vitiated atmosphere. Of course there are some industries for which this power will not be available; but there are many others to which it is exactly adapted, such as the manufacture of ready-made clothing, and all businesses in which the sewing machine is largely used. Mr. Paris demonstrated experimentally the transmission of power to sewing machines supplied by the Singer Sewing Machine Company, and also for such domestic purposes as turning a mangle, a wringing machine, or a knife cleaner. All these very practical demonstrations were highly appreciated by the audience, who were unstinting in their applause. Mr. Paris pointed out that those to whom transmitted power may be supplied by means of electricity are saved not only the cost of space for engine and boiler, but the expense of an engineer, etc. A central station, he explained, has been established by his company in St. Andrew's, Norwich. From this station, sewing machines in London-street are being driven. Mr. Paris alluded to the question of overhead wires, and looked forward to the time that all wires should be underground. The importance of the application of power to small industries was again emphasised, and the chairman, in moving a vote of thanks for the very interesting lecture, pointed out to those present the opening there was for enterprising young men in this work.

A NEW MINERS' ELECTRIC SAFETY LAMP.*

BY OSWALD RICKETTS SWETE, ASSOC.S.T.E. AND E.

At the invitation of Mr. John Higson, I have much pleasure in appearing before you here to-day, in order to give some information concerning the lamp invented and manufactured by the Mining and General Electric Lamp Company, Limited, of 43, Coleman-street, London, E.C.

No doubt many of you here have seen and practically tested various kinds of electric mining lamps, and, therefore, have your own opinions about them; but I think it is generally acknowledged that to obtain a perfect safety lamp it must by necessity be an electric one; since the only light requiring no oxygen to support it, combustion not taking place, is that afforded by the incandescent or electric glow lamp.

After referring to lamps getting current from primary batteries, the lecturer continued:—

Now, let us consider what could be done with secondary batteries. A few years back they were decidedly behind primary batteries, as in the Planté type the active material on the plates was about $\frac{1}{15}$ the total weight of the elements, thereby making a two-cell miner's lamp weigh about 17 pounds.

In the Faure type, more recently brought out, the relation between the dead weight of support and the active material was two to one, making a two-cell miner's lamp probably weigh nine or ten pounds. In 1885, however, a great advance in secondary batteries was made by Mr. D. G. Fitzgerald, inasmuch as he did away with the dead weight of support altogether, and obtained a dense, hard, and highly conductive plate of solid peroxide of lead for his negative element, which he termed lithanode, and containing no support whatever, but wholly consisting of active material, and a two-cell miner's lamp constructed with this kind of element would weigh from four to five pounds.

* Paper read before the Manchester Geological Society, December 11, 1888.

The total weight of secondary batteries per horse-power hour capacity is as follows:

Planté	396	pounds weight.
Faure	198	,, ,,
E.P.S. (L type)	133	,, ,,
,, (S type)	135	,, ,,
Lithanode (old form)	76	,, ,,
,, (latest form)	70	,, ,,

or one-fifth the weight of a Planté battery of the same capacity.

This brings home to us the enormous advantage gained by the use of this new material for secondary batteries, which no other substance yet known can compete with.

Thus, it is the very thing suitable for solving the problem of electric safety lamps. But not only is it applicable to that, but has a far more extensive field of action, such as lighting towns by central stations, houses, railway cars, trams, and omnibuses, and cabs, police and watch lanterns, lamps for powder magzines, and for all purposes where portability, efficiency, and economy are the *sine qua non*. But it is not my purpose to go into those matters to-day.

This small weight, therefore, brings lithanode batteries for mining purposes to the front, other things being equal; but they are more than equal, for besides the light weight of this new type of secondary battery, no renewal of elements is required, nor of the electrolyte (dilute sulphuric acid); no gases evolved on discharging the current through the lamp, therefore no necessity for valves or other complicated arrangements to emit the gas without the liquid. It is this last radical improvement in secondary batteries that is the mainstay of the mining lamp placed before you to-day. Most of you remember, I daresay, the lamp I had the pleasure of showing to you last January at your meeting at Wigan. It was then in its experimental stage, and known in the Wigan district as the "Sun" lamp, but which title, however, the company for cogent reasons have abandoned. This is the outcome of that lamp and the numerous tests which have been undertaken in connection with it.

The E.M.F. is four volts, it consists of two cells, containing one positive and negative element, and bolted together in each cell. Its weight at present is but 5lb., which can be considerably reduced later on. Its candle-power is that of one standard candle. Burns for 12 hours with one charge from a dynamo machine of five hours.

You will observe that the glow lamp can be placed wherever best suits the requirements of the colliery owner—viz., on top, bottom, or side, or may be detached altogether from the battery, as in the case of this small railway reading lamp, ready to be affixed to the coat or cap.

The battery case is made of birch of a peculiar section, occupying as small a space as is possible, exceedingly strong, and rendered waterproof and acid proof by a patented process.

There is another novelty in the glass protector covering the incandescent glow lamp. This consists of toughened or chilled glass, which has great strength, but when broken, instead of cracking or breaking into large fragments, flies to very small particles; a lever pressing against the inside of this glass cover would thereby instantly fall forward if the cover were broken, and this at once cuts off the electric current before the blow that breaks the cover could have time to reach the incandescent lamp, thus rendering it absolutely impossible for an explosion to take place from contact of a red-hot filament with a mixture of air and firedamp.

This cover is capable of being locked with a lead plug, and the miners can be given to understand that in the event of some untoward accident they were entombed within the workings, by picking the lead plug with a pocket-knife, and removing glass cover, the light could be saved up until assistance arrived, which is impossible with any existing oil lamp. The lid is screwed down tight by means of a steel lever and lock nut, and sealed with a lead plug. There is no switch whatever, the action of putting on the cover lights the lamp, and the miner cannot put it out except by breaking the sealed plugs.

By undoing four ebouite nuts inside the battery, the whole of the elements can be instantly withdrawn, for the purpose of repair, etc.

The plates so far have been tested to two years and a half; and are practically indestructible by wear and tear. The total weight of the two sets of elements is 1lb. 2oz.

The lamp can be turned upside down without detriment, and it turned at an angle will not go out, like some oil lamps, thereby saving the "hewer" many a mile's walk.

Now a word as to cost and maintenance. Suppose you want to take 1,000 lamps, what will it cost you? One thousand lamps at 20s. equals £1,000; a 5 unit dynamo machine equals £75; instruments, wires, etc., equals £15; total, £1,090.

Maintenance, per annum: Interest on £1,090 at 5 per cent. equals £54. 10s.; depreciation on £1,090 at 10 per cent. equals £109; current 7 800 units at 7d. equals £227. 10s.; wages, two men at £52 and three boys at £19. 10s. equals £162. 10s.; incidental expenses, equals £10. 10s.; total £564, which is equal to 2½d. per lamp per week, burning 12 hours per day, six days per week.

Now I have charged the current in the maintenance account at 7d. per Board of Trade unit, which is the London price, where coals are at 17s. to 20s. per ton, and rent and wages are far higher than here; therefore, you will readily perceive that I am well within the mark when I say that 2½d. per lamp will cover the cost of maintenance per week. No oil lamp, candles, or primary battery can compete with this, and the saving effected on maintenance alone will soon pay the extra cost of lamps; but beyond everything it is absolutely safe, and a good light, better than that at present obtained from oil lamps

I may add, in conclusion, that this lamp has now been tested for a period extending over nine months in various collieries in the North of England, including the Wigan Coal and Iron Company, Limited; Messrs. Pearson and Knowles, Limited; Dukinfield and Astley Coal Company; Shirecaks Colliery, Limited; Messrs. John Brown and Co.'s Aldwarke Collieries, and the Weardale Iron and Coal Company, Limited; and in all mines has met with a flattering reception.

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THE

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. I., new series, of "THE ELECTRICAL ENGINEER" (Vol. IX., old series) is now ready, and can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

NOTICE.

With our issue of January 6 we gave a Portrait of E. GRAVES, ESQ., *President of the Society of Telegraph Engineers, and stated our intention of giving a series of Portraits of eminent Electricians of the century. In fulfilment of our promise we have already issued a Portrait of* W. H. WOLLASTON, M.D., F.R.S., *and on April 20th we gave that of* SIR HUMPHRY DAVY, F.R.S., *whose fame as an electrician is still more prominent than that of* WOLLASTON. *Portraits of Past Presidents of the Society are in preparation, and we hope soon to have ready that of* PROF. D. E. HUGHES, F.R.S.

SPOLIA OPIMA.

The permanent success of electric lighting depends greatly upon the manner in which the affairs of the recently promoted large companies are carried on. It is with extreme reluctance that we find ourselves compelled to speak strongly upon the explanations made at a recent company's meeting. There seems to have been, even if there has not been, an exceedingly loose method pursued in its promotion, and although the excessive initial price has been largely reduced, the mere fact of it being asked makes us look askance at the future proceedings under the directorate that countenanced such agreements.

To give up close on £40,000 might be thought a philanthropic action, but that depends altogether upon how it is given up. The shareholders of the Metropolitan Electric Supply Company are £40,000 richer than they expected to be, and the curious vision is seen of promoters disgorging some of their booty. Hitherto an octopus or a bulldog might as readily have been expected to have loosed his prey as the promoter his gleanings. The shareholders have to thank those much maligned newspaper fellows for having saved them a sum which in itself is no inconsiderable fortune. There are men connected with the company named whose great desire is to do good work at a fair price, to develop the industry, and to gather honours and riches in due course; while, on the other hand, other men have the sole object to get all they can as quickly as possible. Honestly earned renown seems unknown to the latter. Money is the all-prevailing medium which moves them to action, and their first and last thought to line their pockets. Was *it not* Lawrence Gane who, once lecturing about certain grasps and graballs, and alluding to the all-powerful desire to make money and to keep it, hinted that so fond were they of it that when they joined the majority they would like to take it with them. In his dry humorous way he continued, that if they did take it, it would melt. Far be it from us to suggest any such men are connected with the Metropolitan promotion scheme, and if perchance there should be such, the shareholders should be more than ever thankful that just about £40,000 is reserved from their clutches. The tale is a funny one even in this era of company mongering. From the prospectus it is seen that agreements had been made to pay nearly £80,000 for the goodwill and the machinery of the Whitehall installation syndicate. This amount is a fairly large sum even to millionaires and to greenhorns, whose only fault is blind faith in the *prescriptum* of the promoters. It might be expected that for this sum a thoroughly substantive property would be forthcoming. The property was like that of the artist-lover who would settle £50,000 upon his wife; when further information was wanted as to the £50,000, it was found to be the estimated *future* value

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of a room full of his own paintings. So the property for the £80,000 was mostly in *futures*. Of tangible things, there was a partly finished installation, and the grand possibilities of this and of other installations. The human race consists of wise men and fools—mostly fools—but really this little bill was more than could be swallowed, and so to avoid the outburst from the muttered thunderings, arbitration was the word. The arbitrators have ruthlessly cut adrift one half the price or thereabouts, and saved that amount to the shareholders. There is no doubt even now the arbitrators have been far more generous than just, and that the residue of the purchase money left to the promoters is ample for everything purchased. In the report of the extraordinary meeting of the company, given elsewhere, the chairman, Sir John Pender, alluded to this subject, and had it not been for the peculiarity of his statement we should not have troubled to discuss so fully the matter. We claim to have called attention to the peculiar agreement to take £80,000 from the public—besides founders' shares, of which the last is not yet heard—and we are therefore compelled to state our utter want of faith in Sir John Pender's explanations. They are quisby upon their face, and will not hold together upon the slightest analysis. Are we all so very foolish as to believe a statement that a few friends met together to assist in providing capital to carry out an electric light installation, and that, because they were friends, it did not matter what price was put upon the concern? *If* friends only were in the swim, they knew the exact cost, they knew what money they had to find, and there was no earthly reason why, among friends, the nominal cost should have been watered to about five times the real cost. If the greater part of the £80,000 was not to be taken from the public pocket, why did it go in the prospectus? Was it an attempted *try on?* There is no euphemistic phrase in the English language which can accurately describe the explanation, but the mildest form by which we can describe it is as a very elastic stretch of the imagination.

If it was not intended to get £80,000 from somebody, whence that sum? If it was intended that a goodly sum should pass from the pockets of the public to the pockets of a clique of promoters, we can understand the amount, but on no other supposition. The legal documents called agreements entered into by promoters are to be seen by the paying of a small sum, but we should very much like to go further behind the scenes, and to know the names of those who were to get this £80,000, what they were to get it for, and the proportions they were to get? Suppose we try to make a few calculations. The Whitehall work cost, say, £15,000. This money was provided by certain men, and of course if they sold their interest, there was no reason why they should not make a good profit—allow one hundred per cent.; though if they were so sure of its grand success, and having the command of money, it is difficult to see why they should get rid of the goose that was to lay the golden egg. As a matter of fact, £30,000 would have been a handsome price to get or to pay for the concern. We will, however, suppose a little more, that the prospects for dividend were good, very good, and a few friends were allowed to "come in." Suppose, again, it was suggested what a good thing this would be to go to the public with. "We get £65,000 clear by this purchase agreement. We can guarantee to take a lump of the shares, possibly rig the market, get them a shade above par, sell out most of the shares we apply for, clear a good profit thereon, in the long run getting what shares we hold for nothing, and making a money profit into the bargain. The dividends can be *estimated* at anything; we shall be safe anyway." The nett amount required to pay 5 per cent on £15,000 is £750, an amount fairly accessible; that required to pay 5 per cent on £80,000 is £4,000 or £3,250 more; so that the watering from £15,000 to £80,000 means an annual drag upon the revenue of £3,250 more than it ought to have. The arbitrated sum of £40,000 is bad enough, but that gets rid of £2,000 of the annual incubus. The motto *Spolia Opima* (the richest booty) is suitable to such promoters. Their bowels of compassion are only limited by what they think they can get. The attempted haul in this case caused the net to break, and the great difference between the amount allowed and the amount tried for, added to the doubtful explanation put forward, will lead the public to ponder carefully upon the promises made, and to look forward to the performance with some degree of anxiety.

TRAMWAY WORK.

The time seems opportune to collect information on the various electrical devices that have obtained a footing in tramway work. Neither England nor the Continent of Europe has adopted electricity to any great extent, and therefore it is to America that attention must more especially be directed. There tramways worked electrically are counted by scores, and every mail brings information of other projected lines. In Great Britain some half-dozen lines exist, and there is a feeling abroad that a decided step will soon be made to introduce electrical traction upon other lines. During the past year we have kept steadily in view the necessity of showing not only the practicability of electric traction, but that where introduced it has met with considerable favour, and been commercially successful. No doubt the conditions holding in America are altogether different from those that obtain here, yet knowing what happens in one place must assist in coming to a right conclusion on the subject in any other. One fact is obtained, that the work required to be done can be done by electricity. Trams can be run in crowded and sparsely-used streets. Time tables for running can be compiled and worked up to. Certain causes for delay operate with less effect upon electrically-driven cars than with animal traction. The electrical machinery is less complicated than steam or rope, and less likely to break down. We won't touch much upon the sentimental or

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philanthrophic phases of the question; these apply outside business matters, and have little weight with directors, managers, or shareholders. We are quite satisfied to show that the work can be done, and that it pays to do it. There is one director of telegraph companies who never opens his lips in public without talking balderdash about the money invested in the companies he rules over, and about the aids to civilisation brought about by telegraphs. This man must be a thorough believer in the argument that the world consists of wise men and fools, mostly fools. There is no shareholder, and certainly no speculator who planks down his money for anything except power to pull the strings—or dividends. The investors in tram shares look to dividends, not to sentimentalism, to guide their investments, and managers will decide whether electrical traction is "to be or not to be" entirely from commercial considerations. The two points previously referred to—can it be done? and does it pay to do it?—are those appealing direct to business instincts. These articles, collecting, as they will, the present practice of the world, will give an answer to the first of these questions; the dividends paid and the balance-sheets of the various companies concerned will answer the other. Before the first line or first few lines were constructed, results were estimated. Now, the results are ascertained facts. Amongst other material collected for these articles we have received advanced proofs of a descriptive pamphlet from the Bentley-Knight Electric Railway Company of New

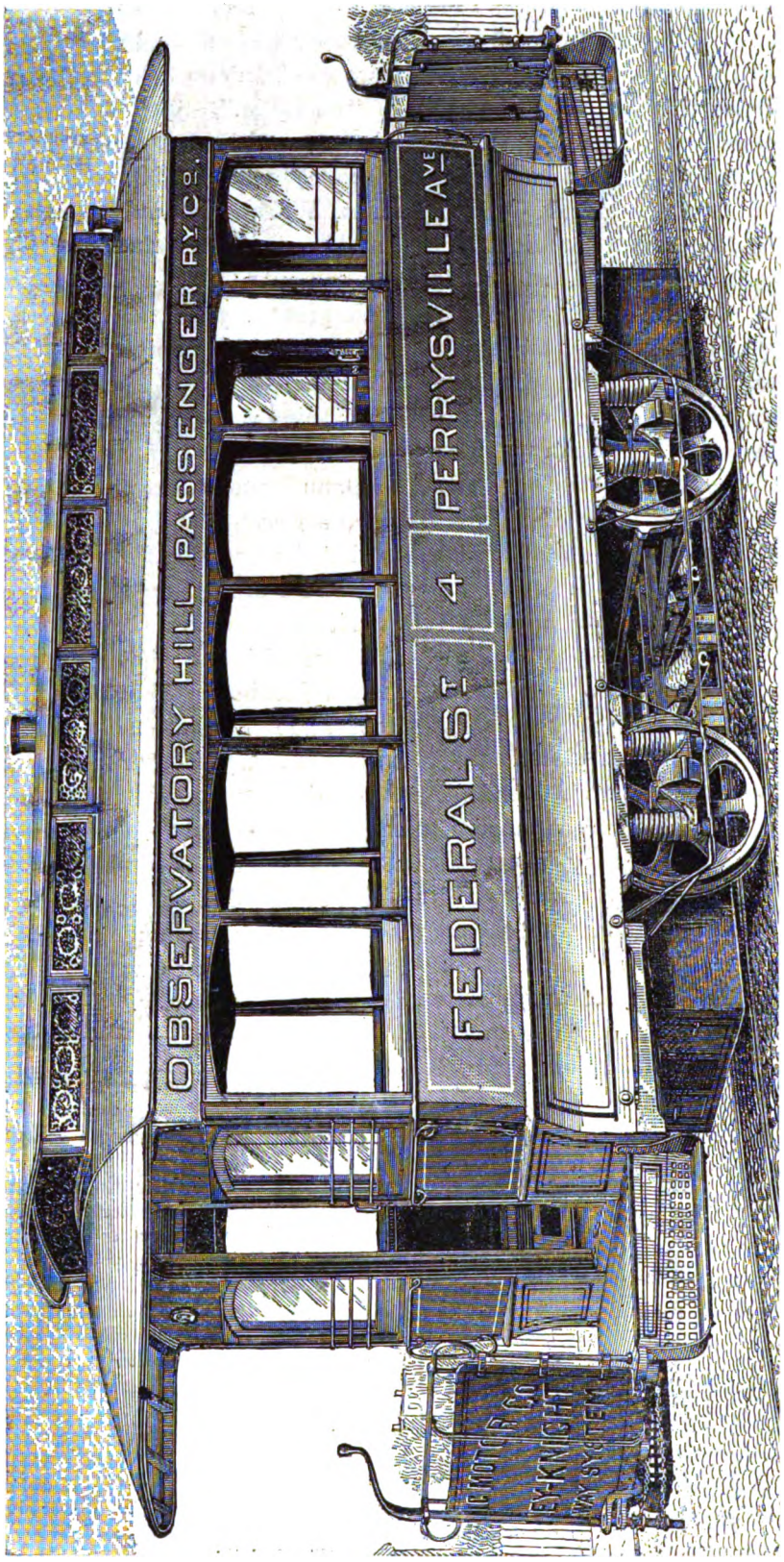

FIG. 1.—Double Motor Truck under Closed Car, as used at Allegheny City, Pa.

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York, which, together with illustrations supplied by the company, we utilise in this article.

The Bentley-Knight System.

The Bentley-Knight system, for use in street railways, consists of a power station—engines, boilers, and dynamo-electric machines—which may be placed wherever property or fuel is cheapest—a conduit running along the whole length of the line, containing the conductors which convey the electric current to the motors, and hanging connections (plows) which pass through the conduit slot, and, sliding along the conductors, maintain unbroken connection between the motors and the source of power. The electric conductors are accessible only to regular employés, furnished with special tools. The current used, even in roads of the heaviest carrying capacity, cannot injure either life or property. The direction and speed of each car are controlled at will from either end. The driver can proceed slowly, almost imperceptibly, when required, and take any desired speed to recover lost time.

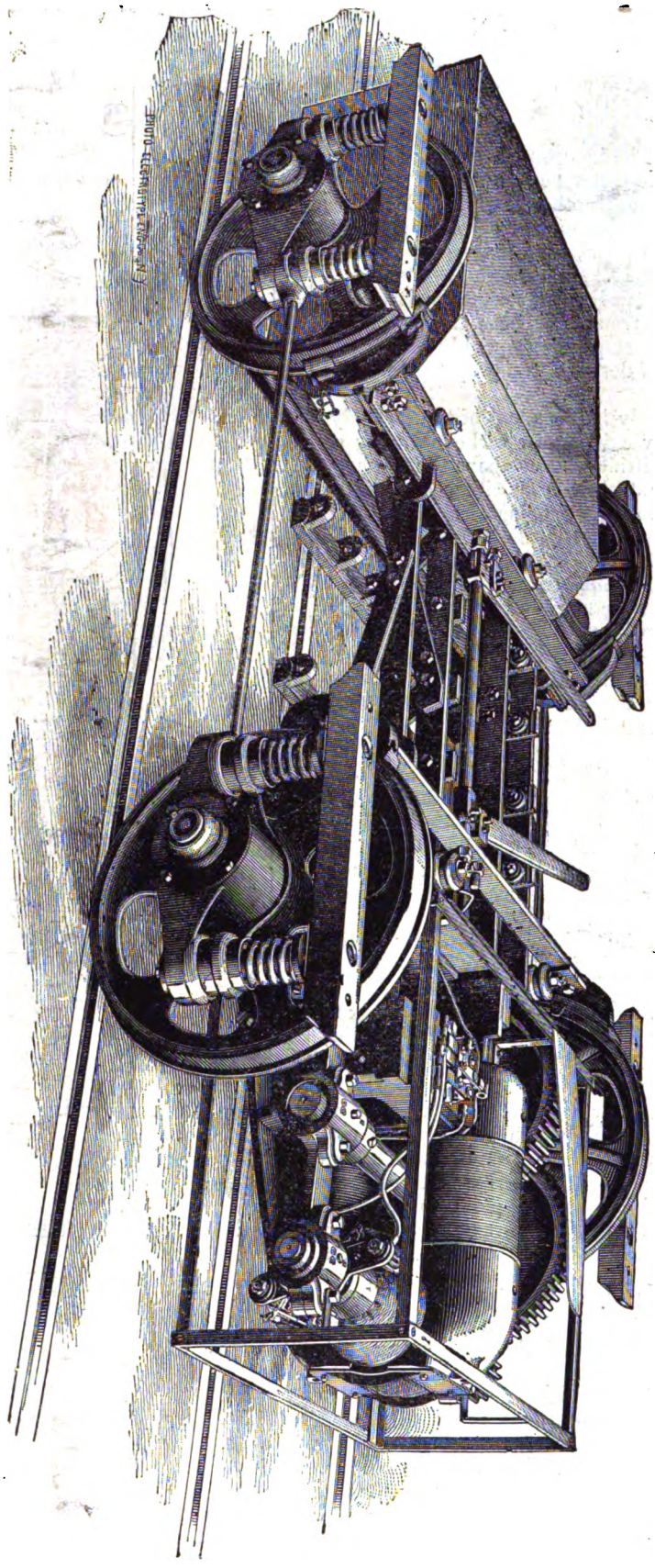

Fig. 2.—Bentley-Knight Double Motor Truck for Extra Heavy Work, as used at Allegheny City, Pa.

In cases where heavy work will be required of the motors, or where excessive strains of any kind must be met, the trucks are equipped with double motors, each motor driving one axle independently. For all ordinary work

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only one motor is employed, mounted upon one axle of the car. The method of motor suspension employed by this company in the construction of its single motor truck concentrates a very large part of the whole weight to be moved upon the driven axle, thus securing ample tractive adhesion.

Each car is entirely independent of any other, and any car, dynamo, or engine may break down without interrupting traffic. A car disabled through accident can be pushed to the depot by the succeeding one, or its plow may be thrown out of the conduit at any point on the line, and the car run off to one side of the track. Any engine or dynamo at the power station may be cut out for any reason and at any time. The independence of the motors and the expansibility of the motor power render the system wholly independent of horses or other reserve. The power consumed is proportioned to the number of cars operated; and, apart from interest on plant, one car may be run with nearly as great economy as 20.

The motor and mechanism of a car operate noiselessly, and are entirely concealed from view beneath the bottom of the car. Cars may be stopped as quickly as desired, may reverse at will, and, if derailed, can propel themselves back on the track

The motor truck is entirely independent of the car-body, and can be put under any existing car without cutting or alterations, and without lifting the car above the ordinary height. The motor is controlled from either end of the car, the only connection necessary being a chain attached to the ordinary brake-spindle. By this arrangement, the ordinary handle, turned in one direction, throws off the brake and starts the car; while, turned in the opposite direction, it stops the car and applies the brake. The motor has a spring support, so that wear on working parts and on the track is very light, while it also permits a yielding impact of the motor on the load at starting. Toothed gearing is used throughout, all journals are held in rigid castings, and the gearing is noiseless, efficient, reliable, and durable.

The commutator brushes are fixed in position, and need no adjustment, either for change in load or direction of rotation. The motor requires but slight attention, and can be put under the car with perfect safety. There is absolutely no flashing or sparking under the heaviest load, and but one set of commutator brushes is used. All journal-boxes are dust-tight.

Motors sufficiently powerful to draw trains of any stated number of cars, instead of equipping each car separately, can, of course, be had.

The same cars which run in city streets at from six to eight miles an hour may be speeded to 20 or 30 miles on suburban extensions, thus saving the change of cars and accomplishing rapid average time on long lines.

The illustrations given show motor trucks adapted to different needs, upon any one of which any kind of car-body may be easily mounted. The conduit, which contains the conductors and supplies the current to the motors along the line, can be placed at any point where the opening of the slot will be below any part of the car-body. It is therefore not necessary to suspend the traffic of a railway or to interfere at all with its operation by horses while the conduit is being laid.

In constructing a conduit line, the iron yokes, C C, are set up from 4ft. to 6ft. apart, and the conductors, G G, set against the insulators which support them at each yoke. The electrical connection between lengths of conductor are then made, the slot-steels, D (Fig. 3), set on the yokes, and the slot-steels and yokes firmly bolted together, leaving a slot opening at the surface of the street of only $\frac{5}{8}$in. The conductors are copper bars connected by expansion joints, and are of sufficient size to carry the current with a loss never greater than 5 per cent. Neither the rails nor the conduit itself form any part of the electrical circuit. The total excavation for the heaviest conduit is 18in. in depth by 16in. in width, while in all ordinary cases a depth of 15in. is amply sufficient.

Electrical connection between the motor and the conductors in the conduit is effected by a contact-plow, which consists of a flat frame, I, hung from the car by transverse guides, P (on which it is free to slide the whole width of the car), and extending thence down through the slot of the conduit. It is so constructed as to adjust itself to all inequalities of road or conduit. This frame carries two flat insulated conductor cores, to the lower ends of which are attached, by spring hinges, small contact-shoes, which slide along in contact with the two conductors in the conduit. At the upper ends are attached connections, Y, leading to the motor. This plow can be inserted or withdrawn through the slot at will, the spring hinges allowing the

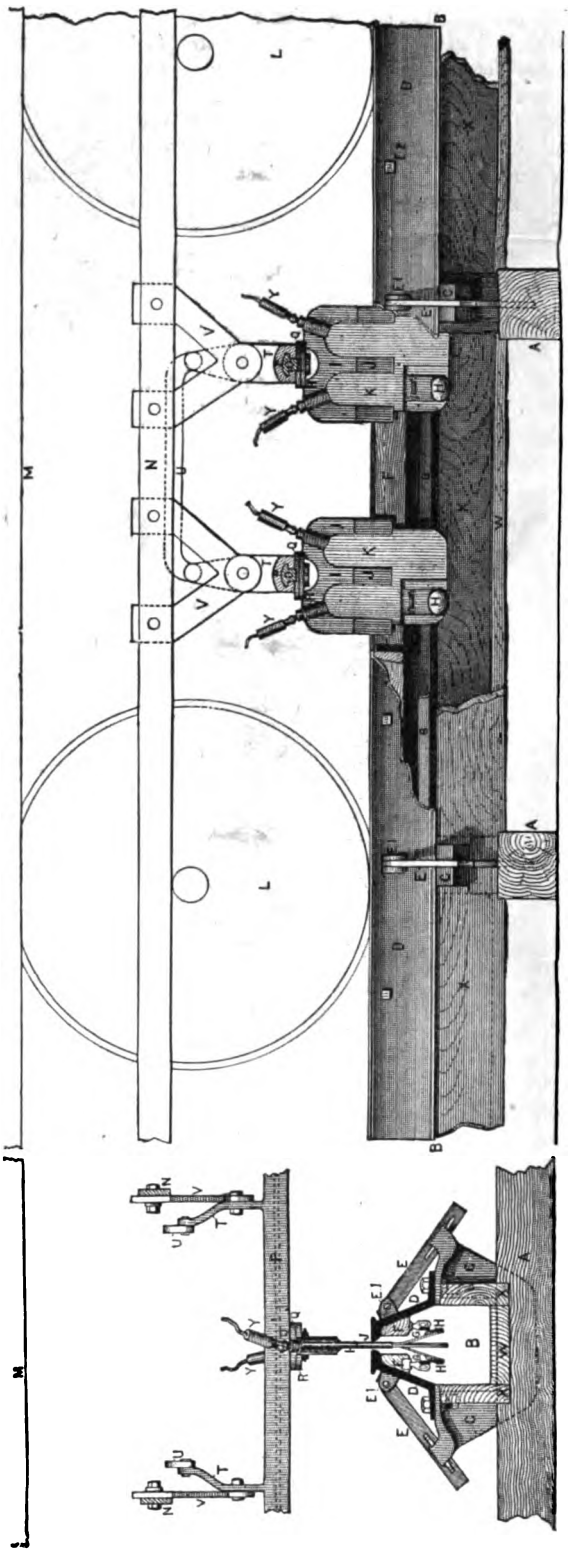

FIG. 3.—Detail Section and Side Elevation of Conduit and Plows. A, Ties; B, Conduit; C, Yoke; D, Slot Steels; E, Braces; E1, Ears; E2, Lag Screws; F, Slot-Steel Lining; G, Conductor; H, Contact Shoes; I, Plow Frame; J, Plow Wearing Plates; K, Plow Insulation; L, Car Wheel; M, Car Bottom; N, Plow Supporting Frame; O, Plow Slide; P, Plow Guide; Q, Upper Bearing; R, Lower Bearing; T, Plow Lever; U, Connecting Rod; V, Plow Supports; W, Conduit Bottom; X, Conduit Sides; Y, Flexible Connections.

contact-shoes to straighten out into line with the conductor-cores when the plow is pulled upward. By no accident, therefore, can anything be left behind in the conduit to obstruct succeeding cars, while the plows may be pulled out at will. The plow-guides are hung on transverse axes, and are held in a vertical position by a spring catch that gives way when the plow meets an irremovable obstruction, and allowing the plow to be thrown completely out of the conduit without injury, it being also

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immediately replaceable. The frame of the plow has wearing guards, J, of hardened steel wherever it can touch the edge of the conduit slot, and the shoes are made of soft metal, which takes up all the wear, and prevents any injury to the conductors. Two plows are used on each car. All wearing parts are made interchangeable.

Elevated Conductors.

For suburban lines, or for small cities where the traffic does not justify the employment of the more expensive conduit system, this company has an elevated conductor system, which is inexpensive and, at the same time, efficient. The elevated conductors can be either bracketed off from poles, or hung from wires crossing the street at any desired height above the roadway. Electrical connection between the motor on the car and the elevated conductors is maintained by means of a trolly or contact brush and a flexible conductor. This system is in practice at Allegheny City, Pa.

This line has been in continuous operation since January, 1888, and in its construction, equipment, and operation, almost every possible difficulty to be met in street railway work has been successfully overcome.

The line is about four miles in length. For one-fourth of this distance the electric conductors are contained in a sub-surface conduit. For the remainder of the line the conductors are elevated above the roadway, being bracketed off from poles erected along one side of the street. The conduit branches from double to single track, and at the

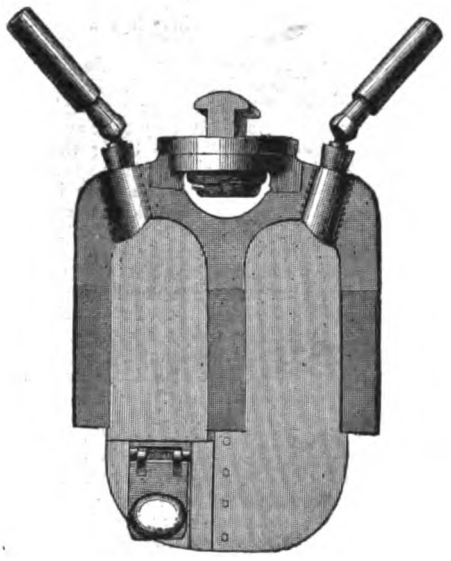

Fig. 4.—Conduit Plow.

present terminus of the line there is a conduit cross-over switch from down to up track. At different points along the conduit section, the conduit cuts through five other street railway tracks belonging to other companies. On the elevated conductor section the line is single track, with seven turn-outs. Double conductors are used throughout both conduit and elevated conductor sections, neither the rails nor any part of the conduit itself being used as a part of the electric circuit. Almost the entire line is built on grade. Nowhere throughout the whole line is there a space 50ft. long where a car will stand without the brakes being applied. There are 34 curves on the line, not including turn-outs or switches. The maximum grade is 12½ft. in 100ft. There is a total rise of 295ft. in 4,900ft.—an average of about 6 per cent. The maximum grade of 12½ is on a reversed curve (radii, 100ft. and 200ft.). The sharpest curve has a 35ft. radius on 5 per cent. grade. Six full-size city cars, each seating 22 passengers, are now in operation upon the line. The motor truck under each car is—owing to the very heavy grades and curves of the line—equipped with two 15 h.p. motors. Each axle is driven separately. The motors are entirely independent of the car body, no part of the motors or mechanism being attached to or cutting through the car floor. Each car is equipped with means for making connection with the conductor on both sections of the line; "plows" being used where the conductors are contained in a conduit, and "trollys" employed on the section where the conductors are elevated above the roadway. The power plant at the station consists of two 100 h.p. boilers, natural gas being the fuel used, one 200 h.p. "Buckeye" engine, and three 75 h.p. dynamos. It is the belief of the company that there is no street railway in existence in the construction and operation of which such great natural difficulties have been met. Even if the enormous cost of the cable system did not preclude the possibility of its adoption for this line, the almost constant curves would render it beyond the power of that system to operate it under any circumstances. The engine power which would be required to operate an electric street railway under average circumstances should not exceed 10 h.p. per car.

The Bentley-Knight Company has just laid three miles of electric conduit at Boston. The conduit at Boston differs from the one at Allegheny City in that it is laid between the two tracks instead of between the rails of each individual track. By this method of construction the railway can operate its line by horses until the very moment that the electrical equipment is ready for use. Both single and double motor trucks are supplied for this line. The latter to pull, if need be, one large two-horse car, besides operating the one under which it is mounted.

In New York, the work of laying conduit similar to that above mentioned at Boston was begun on December 5. It is hoped that two miles will be completed before January 1. This station will be equipped with power equivalent to 300 h.p., to provide for 20 single motor cars. The conduits are laid between the two tracks. This line will be the connecting link across New York between the cities of Brooklyn and Jersey City, feeding the Wall-street, Fulton-street, Cortlandt-street, and Chambers-street ferries.

COMPANIES' MEETINGS.

METROPOLITAN ELECTRIC SUPPLY COMPANY.

An extraordinary general meeting of the Metropolitan Electric Supply Company, Limited, was held on Friday last at Winchester House, Old Broad-street, Sir John Pender, M.P., in the chair.

Mr. E. Cunliffe Owen (the secretary) having read the notice convening the meeting,

The **Chairman** said: Gentlemen, we have called you together to-day for two purposes—to inform you as to the progress the Company has made since August last and as to its present position and prospects; and, secondly, to put before you a resolution approving an agreement made by the Board under the powers of the articles of association to vary the original agreement entered into between this Company and the Whitehall Company for the purchase of the property and undertaking of the Whitehall Company. And first, with respect to the work done, you are aware that the Company took over from the Whitehall Company the important works and installation they had established at Whitehall and the Avenue Theatre. That installation, which is about 10,000 lights, was opened on October 5 last, and the Directors had hoped that the full capacity for lighting would be taken up by customers in seven or eight months; instead of this, the full capacity of the station is taken up already. In about two months orders were booked for nearly 9,000 lamps, and the mains for connecting them are being laid. The Avenue Theatre, the Hotel Victoria, and other places have been lighted for some time, and the managers have written expressing their perfect satisfaction with the supply. Among the more recent contracts secured are the Grand Hotel, Messrs. Hampton's large furniture warehouse in Pall-mall, St. Martin's Church, and other places. The Company's mains are being laid underground throughout the whole of the Charing Cross district, and have already been laid across Northumberland-avenue without any appreciable inconvenience to the traffic. Mr. Gordon informs me that the guaranteed revenue for the contracts made for the works was £13,500, and that further contracts amounting to £1,000 will be completed in a short time, making altogether £14,500 The working expenses, including rent, salaries, wages, are estimated at £6,000, leaving a profit of £8,500 a year on this installation, which I think is fairly satisfactory, seeing that the capital represented by these works is not much over £40,000. The Sardinia-street station we have arranged for. That is a very important station. It embraces important residential property, and some important newspapers are published in the neighbourhood. That district will have, I think, altogether 50,000 lights, and, so far as we can see now, judging from the enquiries, it will not be a very long time after the installation is completed before that will be fully occupied, and if the results from those 50,000 lights are satisfactory in proportion to what we are now seeing from practical working in Whitehall, we may congratulate ourselves upon being in the position of making very handsome dividends. I may mention that the machinery for this station has been ordered from the Westinghouse Company, and the bulk of it will be delivered very shortly. The object, gentlemen, of ordering this of the Westinghouse Company is this: that they have put down in America 116 installations. All those installations have been successful, and

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the principle we have gone upon, and what has been the policy of this Company—because we have not been idle during the past six months—has been to take the very best thing in existence, to utilise that for our purpose, and to bring against the American system, which is almost perfect as far as it has gone, some competition. We are inviting tenders from English contractors in order that we may have the advantage of what I may call contractors' competition. I think the result of that will be to give us the best thing of the kind up to the present moment. I do not mean to say in electricity, as in other things, there is not very great progress. Ten years ago the electric light was merely experimental; it has now become almost universal. It is not more than 25 years since submarine telegraphy was first introduced; there are now £40,000,000 sterling at the bottom of the sea, paying a fair dividend, thus showing we do not know to what extent electricity may be carried; but this we know, that the time has come when electric lighting is becoming the light of the future. I have no hesitation in saying, if you refer to the prospectus, you will find that prospectus was based upon a good deal of experience. You will find that what we said in regard to the American installation ought to be borne out also upon English soil. The Company also took over the extensive and very valuable property for electric lighting purposes, the Waterloo Bridge Wharf, which is admirably adapted for supplying the lighting of the Strand district, and which can take the machinery required for working 150,000 lamps. That, I think, will probably be the largest installation in our system. We want you to understand, gentlemen, we have not gone in the slightest degree on a speculative or experimental policy. We are laying down installations which we know will be successful, so far as the mechanical part of the concern is concerned, and we believe they will be taken up by the public. I think we are not over sanguine in looking forward to a very successful future. The installation, I hope, before another year is out will be in active operation. We know there are very formidable competitors in the market at the present moment. I allude to the enterprise—I may as well name it—the Grosvenor Gallery combination. The gentlemen connected with it are of the highest eminence; they have great practical scientific knowledge amongst them; they have the biggest experiment ever tried in electric lighting, and I hope it may be successful. I hope to see these great efforts of science successful. That is, I believe, a very valuable step in electrical progress. We have been more cautious—probably more prudent; we are not putting all our eggs in one basket. We are arranging our installations so that they are not likely to break down. Every installation will stand alone, or shoulder to shoulder with its neighbouring installation if required. Since August, as I have said, we have not been idle. The Directors have secured several other sites for works—one a large wharf adjoining Southwark Bridge. We have also obtained a site in South-mews, Manchester-square, for Marylebone. With regard to the Strand district, the Company have secured the monopoly for the lighting of the new Salisbury estate. That will be one of the most important improvements, and I hope we shall light that. I cannot say much more on the point of our prospects. In the summer it was said they were encouraging; I think if I were to go over, item by item, every item in the prospectus, I could justify everything that has been said. Now, gentlemen, the second part of the business I hope will also be satisfactory, because it is very much for the Company's interest, although probably not so much for the benefit of others who have been working two or three years, and consider themselves very badly paid. Now, I must say at once that the short result of what we have shown you to-day is to reduce the purchase money payable for the property by the Company; to reduce it from £79,000, the sum named in the prospectus as having been named by the vendors, to practically half, to the very moderate sum of £40,000. This, as I say, you will see is practically reducing the purchase money one half, and I am sure that everyone here will be glad that that reduction is to be made. The vendors are willing to make the reduction, although they are by no means satisfied with the decision which those eminent gentlemen, Sir Frederick Bramwell and Sir Whittaker Ellis, have arrived at with respect to the value of the property. It was, of course, to be expected that the vendors would take a more favourable view of their undertaking than what I may call cold-blooded valuers. The vendors made arrangements with the Company when there were no shareholders but themselves and their friends, and it did not seem necessary to do more than to see there was a substantial basis for the price to be paid. No man could then, nor could he even now, estimate absolutely what is the value of the undertaking we have purchased. I have told you of our prospects; probably a year hence our stock may be worth twice or thrice what it is to-day. Therefore, you see the difficulty of valuing a thing which is not realised. In this valuation I believe nothing has been taken into consideration as to the valuable and favourable prospects of the Company. But one thing is, I think, clear—that the valuers have not taken into consideration what was largely in the minds of the vendors, and that is what I have just stated. I do not know what was in the minds of the valuers. They have, wisely, perhaps, given no reason for their decision; but from the course of enquiries which they made very carefully in respect to the properties actually transferred, and the prospects for the future, I have no doubt they omitted from their calculation these elements of future value, which the vendors not unreasonably considered to be so important. I may add that the vendors will be perfectly willing to take back their properties if the Company do not desire to go on with the purchase; but I believe I am quite justified in saying that every member of the Board is convinced that the property is well worth, and more than worth the sum we now decide to pay for it. There is one other item, gentlemen, also to be mentioned, and that is with respect to the provisional orders which the Board of Trade had guaranteed the vendors before the prospectus was issued. These provisional orders gave to the Company valuable rights over the parishes of St. James', Westminster, and St. Martin's-in-the-Fields, and when the Duke of Buckingham refused to suspend the standing orders, which prevented the second reading of the Government Bill to confirm the provisional orders, the Board of Trade promised to use their good offices to support a private Bill to enable the Company to secure the confirmation of the provisional orders in the next session. In consequence of this, I think the valuers must have made a large reduction from the original price. In conclusion, the Chairman said that the South Metropolitan Company was threatened with opposition by the Whitehall, and that was what really brought them together. He moved a resolution for the purpose of "confirming an agreement dated December 12, 1888, made between the Board of Directors of the Company of the first part, and Sir John Pender, Sir George Elliot, Joseph Charles Parkinson, Esq., and the Whitehall Electric Supply Company, Limited, of the second part, for varying the agreement dated July 17, 1888, referred to in the articles of association (clause 6), and made between the South Metropolitan Electric Supply Company, Limited, of the one part, and the Whitehall Electric Supply Company, Limited, of the other part, by which the said Whitehall Company, for the consideration therein mentioned, agreed to convey and assign to the South Metropolitan Company its undertaking, property, and rights as therein mentioned."

Alderman Sir R. N. Fowler seconded the resolution, which was carried.

The **Chairman** added that the Company had given notice of a Bill in Parliament to obtain parliamentary power *to carry on the works* of St. James, Westminster, St. Martin-in-the-Fields, and Waterloo Bridge, which would include the ground covered by the provisional orders obtained last summer. They had also given notice for provisional orders in various other parts of London. He added that the Directors viewed the prospects of the Company as very encouraging.

A vote of thanks to the Chairman and Directors then terminated the proceedings.

LONDON ELECTRIC SUPPLY CORPORATION.

The second ordinary general meeting of the London Electric Supply Corporation, Limited, was held on Friday last, at Winchester House, Old Broad-street.

Major C. B. Waller read the notice convening the meeting, and the report of the Directors was taken as read.

The **Earl of Crawford and Balcarres** presided, and, in moving the adoption of the report, stated that they took over the installation at the Grosvenor Gallery in 1887, there being then about 11,000 lamps. The Directors of the previous company spent a considerable sum in order to place their dynamos and engines in a very advantageous position; and they contracted with the engineer to supply dynamos sufficient to give the current to 20,000 lights. It was afterwards found, when the two machines were put into position, that the nominal efficiency of 20,000 lights could be safely exceeded, and the present Company came into possession of two dynamos capable of giving 30,000 lights. In addition to that there was a system of engines which was very complete, but the engines were not quite sufficient for the large amount of work demanded from them at present. They had purchased a large system of overhead mains—cables for conveying the current from the generating station to the houses of the consumers. A good deal had been said as to the safety of overhead wires. They had every confidence in their system. The best material was used and the work was efficiently done. To satisfy the Board of Trade as to the efficiency of their wires they took one down which had been up for three years and seven months, and after it had been thoroughly tested in the presence of the officials of the Board of Trade, the latter acknowledged that it was in perfect condition. At Deptford they had a dynamo with an engine capable of giving 25,000 lights, and they had every reason to hope that that would eventually be equal to supplying 30,000 lights at least. They had also arranged for another dynamo of 25,000 lights. These will be the two first instruments at work, one usually running, the other idle. As soon as that 25,000 dynamo is finished they will have begun erecting the large dynamos, which consist of an engine of 5,000 h.p., running direct on the dynamo, which will be capable of a simultaneous output of 100,000 lights. Two of those will be put up, and, so far, the Directors have already ordered the material. The utilisation of these dynamos—that is to say, the current which they produce—is passed up to London by means of copper mains—of which a sample is here—of a novel construction, and which have done away with all the difficulties which have hitherto been found in electric lighting. Having got these cables, we have to bring the current up so far as London. We knew very well at the time we started this business it would be impossible for us to get parliamentary sanction for going under the streets at the time we thought it desirable to commence work, owing to the ordinary formalities of Parliament, and therefore your Board made arrangements with the railway companies in order to obtain their co-operation, as theirs was practically private property running through different parishes, and therefore not subject to outside jurisdiction. Negotiations with the South-Eastern, the London, Brighton, and South Coast, the Chatham and Dover—the Herne Hill branch—have resulted in obtaining, by means of these three companies, way-leaves, whereby they can bring the current all the way in an easy and most practical manner into the heart of London. They bring the current across the bridge into Cannon-street. Rather before that the Directors entered into arrangement with one of the railways for the use of their tunnels. I am not able to say that we have the complete circuit at the present moment, because a certain portion is still under negotiation, although the principle is conceded and the agreement practically finished. The only question outstanding is, how much per mile we are to pay? I think you may trust your Directors to fight for that being as little as possible. That brings us practically up to London, and our first thing is to carry the mains throughout the town, first by overhead mains, and subsequently, when we obtain provisional orders, by means of taking the

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streets up and putting mains down underground. We have asked for powers to deal with the streets in 24 different localities, under the jurisdiction of 24 different local authorities. So far as we have gone through the work we have given the notice; previous to that we gave notice also for licenses. Well, by the Act of 1882, there were two methods of procedure, one by licence, which requires the consent of local authority and the Board of Trade giving permission for any work to be done; the other method being that of provisional orders, where the Board have power on good reason to dispense with the assent of the local authority, and Parliament grant permission to proceed. Within the last fortnight the Board of Trade decided it would not exercise the first of these powers, and refused to give licenses to anybody in the metropolis; we are therefore thrown back on the provisional orders. They thought the Board of Trade was wise in dealing with such a large question in saying Parliament should have a voice, but at the same time the Board of Trade would have acted fairer if they had decided two months earlier, when we should have been spared the expense of applying for the licenses. As regards provisional orders, there is a certain amount of difficulty which must accrue in future; but our business has been placed very nearly in a unique position so far as the commercial business of this Company is concerned. We are providing people, doing certain work permissively, are recognised to a certain extent by the Legislature; but at the same time are bound down and hampered, and forced to do many things which it may not be our interest to do. An ordinary business at the commencement will work slowly, will do everything to ensure a larger possible revenue, and is not bound to do more work than will bring in a dividend in the course of any period, but the Act of 1882 gives power to the local authority, after a certain period of time has elapsed, to say you shall do certain works for us now, and if you do not do that within six months there comes a certain amount of fine. Well, negotiations have been made with the local authorities to get that time put back as remotely as possible. They all wish to say, "You shall be compelled to do that which we ask you to do," so that the local authorities may require us to run mains into places for their own convenience, and require us to light a street, for instance, which would not pay a remunerative sum for the capital laid out on the mains. There is only one redeeming point in that, and that is, the local authority is bound to promise you for three years that they shall take current to the amount of 20 per cent. on the outlay which is incurred, therefore it may have a certain amount of deterring influence, and it may be doubtful whether we shall be called upon to do this or not. But still we must struggle to have that put back as far as possible. Certain vestries have been asked to allow it to be two years. He would move that the report be adopted, and after that had been seconded, he would be very glad to answer any questions that might be asked.

Sir Coutts Lindsay, in seconding the motion, said he believed that the working of the previous company would conduce to the success of the Corporation, in the prosperity of which the Directors held an overwhelming interest.

In reply to a question of Mr. McLea, the **Chairman** said it was probable that the Metropolitan Electric Supply Company had applied for provisional orders in the same districts as themselves.

The resolution was carried unanimously.

The **Chairman**: We now come to the second portion of our business, the question of the future financial arrangements of the Company. And here it will be necessary for me to refer to what passed at our last general meeting. The capital of the Company consists of 250,000 fully-paid shares, 125,000 upon which £4 have been paid, and £180,000 debentures, which it will be in your memory were created by resolution at our last meeting. Your Directors were empowered at that time to issue their debentures to a member of their Board, Lord Wantage; he has taken up a certain number of the debentures and the conversion as at that time suggested has been carried out, and before the end of this year the debenture debt of this Company will be wiped out, and the 36,000 shares of Lord Wantage will be actually paid up in full. Therefore we are in a very happy, comfortable position so far as that is concerned. It may seem strange to some of the shareholders that the Directors ask to increase the capital while yet there is a certain amount of ordinary capital in hand. They may also ask, "Why do you want any more money at all at present?" With regard to the money, we shall be able to satisfy you. With regard to the business down at Deptford, we made the most careful estimates we were able to, and think our estimates have come out within a very small amount of what we consider will be actually required; but in money so subscribed for this thing we did not feel quite certain at the time we had sufficient money to do that which we wanted, and, therefore, although we may want £30,000 or £40,000 more than we have at the present moment, still we are not that amount wrong in the estimate. We estimate we may require £40,000 in order to complete the works and have machinery going capable of giving simultaneously 150,000 lights and keeping 100,000 in reserve. At the present moment we have let it be known, to a certain extent, that we shall be in certain quarters of London before very long. We have done this in order to let people know we are coming there, and to feel the pulse of the inhabitants of those portions of the metropolis, so as to see what customers we are likely to obtain. The response to our circular would take up the whole supply that we would be able to put down. If we had 150,000 lights ready now, we could place them in the course of next week. That is a very healthy position to be placed in. In conclusion, the Chairman said that the Directors wanted power to put up sufficient machinery for 200,000 lights more. He said he thought it would be enormously to the advantage of the Corporation to have such power in their hands. He moved a resolution: "To increase the capital of the Company by the creation of 50,000 new shares of £5 each, to be called preference shares (with power for the Company to create further new shares to rank in all respects *pari passu* with the said preference shares), to all of which shares shall be attached the following rights and privileges—viz. (1) The holders of such preference shares shall be entitled, out of the profits of each year, to a preferential dividend on the capital for the time being paid up on such shares respectively, at such rate as the Board before the issue thereof shall fix; but without a right to any further participation in profits. (2) That in the event of the Company being wound up, the holders of the said preference shares shall be entitled to have the surplus assets of the Company applied in the first instance in repaying to them the amount paid up on shares held by them respectively, the residue of such surplus assets being divided among the holders of the other shares of the Company (hereinafter called ordinary shares). (3) Any holder of the preference shares shall be entitled, at any time within five years from December 31, 1888, to relinquish the preferential rights of such of the said preference shares as are held by him and are paid up in full, and thereupon each of such shares shall thereafter become and be ordinary shares of the Company.

Lord Wantage seconded the resolution, which was carried unanimously.

A vote of thanks to the Chairman and Directors terminated the proceedings.

CITY NOTES.

West India and Panama Telegraph Company.—The receipts of this Company for the half-month ended December 15 show a decrease of £17, as compared with the corresponding period.

Metropolitan Electric Supply Company, Limited.—It is stated by this Company that certificates for shares are ready and may be exchanged for letters of allotment on and after December 28 at the Company's offices.

Eastern Telegraph Company, Limited.—This Company announce the payment, on January 14 next, of interest at the rate of 3s. per share on the preference shares of the Company, less income-tax, for the quarter ending December 31, 1888, and on the same day an interim dividend will be paid of 2s. 6d. per share in respect of profits for the quarter ended September 30, 1888, on the ordinary shares of the Company, free of income-tax.

PROVISIONAL PATENTS, 1888.

DECEMBER 14.

18,245. **Improvements in electric lamps or lighting apparatus.** Carl Coerper, 45, Southampton-buildings, London. (Complete specification.)

18,255. **Improvements in electric alarms.** N. G. Thompson, 7, Westminster-chambers, Victoria-street, London, S.W.

18,262. **An electric speed regulator for marine engines.** Peter Wilhelm Sothmamm and Carl Otto Heinrich Kroll, 142, Fleet-street, London.

18,278. **Improvements in laying electrical conductors under ground.** George Wilkinson and Leonard William Holmes, 17, Coleman-street, E.C.

18,306. **Improvements in the construction of apparatus for communicating currents of electricity to persons on the introduction of specified coins or checks.** Auguste Serraillier, James Tarbotton Armstrong, and The Automatic Electric Supply Company, Limited, Suffolk House, Lawrence Pountney-hill, London, E.C.

DECEMBER 15.

18,319. **Improvements in or relating to suspenders for shades or lamps, especially applicable to electric lamps.** Wilfrid Swanick Boult, 323, High Holborn, Middlesex.

18,331. **Improvements in electro-dynamic engines for hauling or propelling vehicles on railways and tramways.** Henry Percy Holt, 70, Market-street, Manchester.

DECEMBER 17.

18,389. **An improved instrument for regulating electro-motive force.** William Henry Douglas and Thomas Hugh Parker, 77, Colmore-row, Birmingham.

18,416. **Improvements in apparatus for measuring currents of electricity.** Marie Jules Raoul Jacquemier, 28, Southampton-buildings, London, W.C. (Complete specification.)

DECEMBER 18.

18,450. **Improvements in dynamo-electric machines and electric motors.** James Yate Johnson, 47, Lincoln's-inn-fields, Middlesex. (Charles S. Bradley, United States.)

18,494. **Improvements in galvanic batteries and in the arts.** Isaiah Lewis Roberts and Henry Leffert Brevoort, 76, Chancery-lane, London, W.C. (Complete specification.)

18,505. **Improvements in electrical torches for lighting gas.** Henry Brinsley Sheridan, 156, Strand, London, W.C. (James Darius Culp, United States.)

18,525. **Improvements in alternate current motors.** Ernest Wilson, 28, Southampton-buildings, Chancery-lane, London, W.C.

18,526. **Improvements in submarine telegraph cables.** Johann Carl Ludwig Loeffler, 28, Southampton-buildings, Chancery-lane, London, W.C.

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DECEMBER 19.

18,589. **Improvements relating to secondary batteries.** Joseph Leopold Huber, 45, Southampton-buildings, London.

18,608. **Electric bells.** Robert William Paul, 10, Ravendale-road, Stamford Hill, N.

18,636. **Improvements in electrical accumulators.** John Crisp Fuller and George Fuller, 33, Chancery-lane, London.

DECEMBER 20.

18,659. **An improvement in electric motors worked by alternating currents.** Siemens Brothers and Co., Limited, 28, Southampton-buildings, Chancery-lane, London, W.C. (Alfred Miles Taylor, India.)

18,660. **An improved manufacture of wire coated with copper or other metal for electrical conductors and other purposes.** Edourd Martin, 28, Southampton-buildings, London, W.C.

COMPLETE SPECIFICATIONS ACCEPTED.

DECEMBER 14, 1887.

17,209. **A combined switch and electric lamp support for public and private conveyances.** James Willing, the Younger, and Arthur Douglas Douglass, 57, Chancery-lane, W.C.

JANUARY 24, 1888.

1091. **An improvement in or connected with counting or recording mechanism released electrically.** David Alfred Aird, 166, Fleet-street, London, E.C.

JANUARY 27, 1888.

1254. **Improvements in forming metallic connections with incandescent electric lamps, and holders therefor.** John Spink and Charles Gauzentes, Sunbridge Chambers, Bradford, Yorkshire.

FEBRUARY 7, 1888.

1798. **Improvements in telephonic transmitters.** Thomas Laurie, 115, St. Vincent-street, Glasgow.

1843. **Improvements in rheostats and rheotomes.** John Clayton Mewburn, 169, Fleet street, London. (La Société Anonyme pour la Transmission de la Force par l'Electricité, France.)

FEBRUARY 8, 1888.

1919. **An improvement in arc electric lamps.** Arthur James Howes, 28, Southampton-buildings, Chancery-lane, London, W.C.

FEBRUARY 11, 1888.

2073. **An improved electric alarm apparatus.** Armand C. Iwanowski, 45, Southampton-buildings, London.

FEBRUARY 14, 1888.

2251. **Improvements in switches for electric circuits.** Alfred Graham, 47, Lincoln's-inn-fields, London.

FEBRUARY 16, 1888.

2368. **An improved method of manufacturing woven plates for secondary batteries.** Mark Bailey and John Warner, 21, Finsbury-pavement, London, E.C.

FEBRUARY 18, 1888.

2438. **Improvements in the manufacture of illuminating conductors for incandescent electric lamps.** Rudolf Langhans, 45, Southampton-buildings, London.

2450. **Improvements in electrical measuring instruments.** Walter Hibbert, 8, St. Dunstan's-road, West Kensington, London, Middlesex.

JUNE 19, 1888.

8950. **Improvements in applying electrical traction to pleasure, sporting, and business purposes.** Charles Barnard Burdon, 321, High Holborn, London, W.C.

JULY 21, 1888.

10,604. **Improvements in the elements for secondary batteries.** Illius Augustus Timmis, 2, Great George-street, Westminster, S.W.

JULY 31, 1888.

11,082. **An improved mode of and apparatus for transmitting and recording electrically autographic messages, signals, and markings.** Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, Middlesex. (Elisha Gray, United States.)

NOVEMBER 7, 1888.

16,099. **Improvements in the construction of electrical switches, cut-outs, ceiling and wall connecters.** Charles Mark Dorman and Reginald Arthur Smith, 24, Brasenose-street, Manchester.

NOVEMBER 17, 1888.

16,703. **Improvements in lixiviating batteries for raw sugar or sugar mass.** Carl Steffen, 115, Cannon-street.

SPECIFICATIONS PUBLISHED.

1887.

12,676. **Dynamo-electric generators, &c.** W. T. Goolden and L. B. Atkinson. 8d.

17,231. **Distributing electricity.** H. Edmunds. 8d.

1888.

718. **Self-acting electric batteries.** E. Guitton. (Sappey.) 11d.

981. **Electric "call" signal apparatus.** C. Spratt. 11d.

984. **Controlling railway signal levers by electricity.** W. F. Burleigh. 8d.

985. **Interlocking apparatus for railways.** W. F. Burleigh. 8d.

13,598. **Electric motors.** R. R. Hutchinson. 8d.

14,980. **Operating capstans, &c., by electricity.** R. R. Hutchinson. 6d.

14,981. **Actuating printing machinery by an electric current, &c.** R. R. Hutchinson. 8d.

14,982. **Operating railway and tramway turntables.** R. R. Hutchinson. 6d.

14,983. **Telpher lines, &c.** R. R. Hutchinson. 8d.

14,985. **Utilising a current of electricity for pile-driving machinery, &c.** R. R. Hutchinson. 8d.

14,986. **Applying electricity as a motive power to cranes, sheer legs, &c.** R. R. Hutchinson. 6d.

14,988. **Brewing, &c., "mashers" and "mixers," and applying electricity as a motive power for same.** R. R. Hutchinson. 8d.

14,989. **Steering apparatus for ships, and utilising electricity as a motive power for same.** R. R. Hutchinson. 8d.

COMPANIES' STOCK AND SHARE LIST.

Dividend.		Name.	Paid.	Price. Wednesday
2 July	4%	African Direct 4%	100	101
12 Feb.	1/2	Anglo-American Brush E.L.	4	4¼
12 Feb.	2/0	— fully paid	5	5¼
26 Oct.	7/6	Anglo-American	100	47
26 Oct.	15/0	— Pref.	100	69
12 Feb., 85	5/0	— Def.	100	15⅜
14 Nov.	5/0	Brazilian Submarine	10	13½
14 Nov.	0/4½	Con Telephone & Main	1	⅜
10 Aug.	9/0	Cuba	10	14½
10 Aug.	10/0	— 10% Pref.	10	19
12 Oct.	2/0	Direct Spanish	5	4½
12 Oct.	5/0	— 10% Pref.	5	10
26 Oct.	2/0	Direct United States	20	9½
12 Oct.	2/6	Eastern	10	12¼
12 Oct.	3/0	— 6% Pref.	10	15
1 Aug.	5%	— 5%, 1899	100	109
26 Oct.	4%	— 4% Deb. Stock	100	106
12 Oct.	2/6	Eastern Extension, Australasia & China	10	12⅜
1 Aug.	6%	— 6% Deb., 1891	100	106
2 July	5%	— 5% Deb., 1900	100	106
2 Nov.	5%	— — 1890	100	102
2 July	5%	Eastern & S. African, 1900	100	106
28 Mar.	8/8	German Union	10	9½
12 Oct.	1/0	Globe Telegraph Trust	10	6⅞
12 Oct.	3/0	— 6% Pref.	10	14½
30 April	5/0	Great Northern	10	14¾

Dividend.		Name.	Paid.	Price. Wednesday.
1 March	5%	Gt. Northern 5% Deb., '83.	100	106
27 July	10/0	India Rubber, G. P. & Tel.	10	17½
26 Oct.	12/6	Indo-European	25	40
14 Nov.	2/6	London Platino-Brazilian	10	8
16 Mar.	5%	Maxim Weston	1	⅛
30 May	2½%	Oriental Telephone	11	½
26 April	4/0	Reuter's	8	7½
		Swan United	3½	2⅝
10 Aug.	13½%	Submarine	100	145
15 Oct.	6%	Submarine Cable Trust	100	97
12 July	12/0	Telegraph Construction	12	40½
2 July	6/0	— 6%, 1889	100	105
29 Nov.	5/0	United Telephone	5	14
27 July	3/0	West African	10	8
1 Sep.	5%	— 5% Debs.	100	99
12 July	4/0	West Coast of America	10	9½
30 June	8%	— 8% Debs.	100	125
26 Oct.	6/0	Western and Brazilian	15	13½
26 Oct.	6/	— Preferred	7½	6¼
11 May	2/1½	— Deferred	7½	6⅜
1 Aug.	6%	— 6% A	100	109
1 Aug.	6%	— 6% B	100	107
		West India and Panama	10	1⅜
29 Nov.	12/0	— 6% 1st Pref.	10	11⅜
13 May, '80		— 6% 2nd Pref.	10	12
2 Nov.	7%	West Union of U.S.	$1,000	122
1 Mar.	6%	— 6% Sterling	100	10a

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